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ON THE PLACE OF ECONOMIC ZOOLOGY IN A MODERN UNIVERSITY.*

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The time has come when it is necessary for us to consider very carefully the position of Economic Biology, not only in relation to the State, but also in relation to the Universities. I think it may be said that some of our influential men, and some of our public bodies, are beginning to realise that the scientific study of Zoology and of Botany possesses something more than a purely academic interest, and that when applied to certain problems that affect the public health and some branches of our national industries, it has yielded practical economic results. The Universities, on the other hand, are beginning to realize that the investigation of problems which have some bearing upon industry and public health is of importance in the development of their Schools of Biology, and it is not inconsistent with the maintenance of high scientific ideals.

There is undoubtedly a growing demand for the services of men qualified to deal with the problems of Economic Biology, and it appears to me it is the duty of the Universities to provide a course of instruction and training specially adapted for that small class of students who are prepared to make the study of these problems their work in life. There may be many differences of opinion as to the best way to educate a young man who wishes to devote his life to Economic Zoology or Botany, and to gain his living professionally by the exercise of his skill and knowledge of these subjects; but there can be no manner of question that the economic biologist of to-day requires a wider and more profound training than was expected of him in the past.

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Let us consider then, in the first place, the kind of training that might reasonably be expected of a man who is a candidate for a post as a teacher of Economic Zoology, or who is seeking to obtain a position as an adviser to a colony or to an agricultural company possessed of large estates in any part of the world, on the animal pests of the crops.

Not so very long ago, and to some extent to-day, the type of man who was considered to be best qualified for a post of this description was the man who is called "a good field entomologist," and it was thought that if he possessed a detailed acquaintance with the principal insect pests of agricultural crops, a general knowledge of theoretical and practical zoology was unnecessary. The student who had passed through the usual University course of studies and taken a degree with Honours in Zoology was regarded as a "Laboratory man," and of very little practical utility.

A good practical acquaintance with agricultural entomology is, and always must be, the important weapon in the hands of the Economic Zoologist, but he needs more than that if he wishes to deal successfully with the problems of his profession. He needs a general acquaintance with the principles of zoology, a practical knowledge of the methods used in a zoological laboratory, and the means of obtaining information about the progress of zoological research in the branches of the science that are of special interest to him.

It is not perhaps necessary for the student to have a very detailed knowledge of all the classes of the animal kingdom, and it is possible that the pressure of time would necessitate the omission of some groups of animals from the curriculum, but his knowledge of zoology should be sufficient to enable him to follow without difficulty lectures on Parasitism, Parthenogenesis, Heredity, and Embryology in which illustrative examples from any group of animals are used.

The special groups that a student should study are the Protozoa, the parasitic worms, the fresh water and terrestrial Mollusca, and particularly the tracheate Arthropoda, and I should regard it as of special importance that he should have a full course of practical work in the dissection of Arthropoda, and in the methods of microscopic investigation.

Such a course of study as I have sketched is one that could be given in the zoological departments of the principal Universities of our country without very much additional equipment, or a very material addition to the numbers of the teaching staff.

But in order that the student may have the opportunity of getting

some training in the recognition of insect pests in the field, the work of the laboratory should be supplemented by some systematic teaching in connection with an institution of the nature of an agricultural college, in which access to growing crops may be facilitated.

Whatever steps may be taken to provide for the training of economic zoologists by the Universities, it is quite clear that they cannot expect to be able to complete their education in a three years' course. If a given University is able to give them facilities for the study of agricultural pests, it will probably be unable to provide them with the pests of forests, and still more unlikely that it will be able to afford them much practical experience of the pests of tropical produce plants, such as the cotton plant, the sugar cane, the rubber trees, or the tea and coffee plants.

The education of an economic zoologist will not be finished until the end of his life-time. Wherever he may go, and whatever problem or set of problems he undertakes to investigate, he will find facts and conditions that are new to him, however thorough his preliminary education may have been. When he leaves his University or College, therefore, he must go on learning, and it is of the utmost importance that the training he receives before he goes out into the world should be of such a character as to render his post-graduate education as easy and rapid as possible. It is for this reason that I believe that the knowledge and training of the man who is known as a good field entomologist, valuable and indeed essential as they are, are not sufficient for the practical economic zoologist. He must have, in addition, a thorough scientific training similar to that of the University Honours student in one of the Biological subjects.

I do not suggest that the ordinary courses by which University students are trained for a degree in Science with Honours in Zoology, are, by any means the best that can be designed for the economic zoologists. It seems to me that the Universities have exhibited a tendency to underrate and depreciate the tastes and accomplishments of the young field naturalists, who enter upon their courses as students of zoology. Too frequently such students have had no opportunity in the final examinations of showing that kind of knowledge they have acquired before they came up to the University, and have widened and deepened, by their own private study, during the years they have spent in the University. The type of student that should be encouraged to pursue the study of economic zoology is the one that, whether by his observations of the life and habits of wild animals, or by his zeal as a collector of some group of insects,

has shown some ability as a field naturalist. Opportunities should be given to him to enlarge the scope of his favourite pursuits, and care should be taken that credit is given to him for his special knowledge in the final examination. I do not believe that a good field naturalist, like a good poet, must be born and cannot be made. I do not despair of making a good field naturalist of a clever boy, who has had no previous experience of field work, provided that he comes to me with a decided taste for scientific pursuits, some powers of observation and a determination to conquer difficulties. Nor on the other hand do I assume that a boy who has proved his abilities as a field naturalist is necessarily going to turn out a good economic zoologist. But, having got into the laboratory, students who for one reason or another show promise of good work, there are two features in their training which in my opinion are essential for the successful pursuit of economic work. One year should be almost entirely devoted to the special study of the structure and life-history of Insects. In the ordinary course of University studies, this will be the third or final year. Some opportunity should then be given to him to devote at least one year to the pursuit of some piece of post-graduate work of the nature of an original investigation under the guidance of his teachers, in order that he may learn the methods of research and the way to overcome technical difficulties.

It will probably be found that the greatest difficulty will arise in the provision for this last year of post-graduate study, for when a man has taken his degree he is himself naturally anxious to begin to earn his own living, or he finds, only too frequently, that the money that has been provided for his education is exhausted, and some paid appointment is a necessity. To help us out of this difficulty I think we might appeal to the public authorities for some substantial assistance.

There can be no doubt, I imagine, in the minds of any of those who have come into contact with the many questions of Economic Biology, that there is a great and increasing demand for the services of young men with special knowledge of these subjects, and that there is even a greater difficulty in finding properly qualified young men to fill the posts that are offered.

There are very few professions in which it can be said that the demand is greater than the supply, and yet it is true that in the profession of economic zoologists, there are not at the present time nearly enough qualified men to do the work that is required. It is true that the profession does not offer many very highly paid posts, and that for many years the young professional man will have to be

content with a very modest stipend, but I believe there are better times in store, and that when the public begin to appreciate better than they do at present, the immense commercial importance of the scientific treatment of household and agricultural pests both at home in the colonies, the remuneration of the more experienced and skilled men in the profession will be considerably improved. It is not without very careful consideration that I have ventured to express my opinion upon this point, for I feel that a very heavy responsibility rests upon those who are in a position to offer advice to young people at the age when their career must be determined, and I could not recommend to anyone (unless endowed with private means), a course of study and training which does not lead to a career of remunerated work.

At the present time there is admittedly a difficulty in all the Universities in getting students to devote their time to the study of Economic Zoology. We all know that the ignorance of the average Englishman of the facts and principles of zoology is profound, and it will be a long time before the general public is convinced that they can have any useful application. It is no wonder therefore that the parents hesitate before embarking their sons upon a career about which they know nothing and care less.

But nevertheless the public services demand the labour of men with a special training in Economic Zoology, and it is in the public interest that the supply of duly qualified men should be assured.

It is for this reason that I feel that an appeal for financial assistance for young men of ability who have embarked upon a recognized course of study, but are unable, without such assistance, to complete the fourth year of post-graduate work, is desirable. It is not my purpose to discuss in this paper the important questions of the opportune time and manner of making this appeal, I only wish to point out to you what appears to me the weak link in the chain of our educational system as regards the study of economic zoology, and to suggest that it should be strengthened.

It is of very little use for the public to spend money upon the scientific investigation of the pests of farm crops, of the insects that attack forest trees, and upon subjects of a similar kind unless the services of properly-trained persons can be secured. At the present day there is undoubtedly a shortage of such persons, and consequently the first step must be to endeavour to bring the supply up to the level of the demand, and for this there is a pressing need of financial help. It is possible that this financial help will be necessary only for a limited number of years. If it be proved, as I think

it will be, that there is a career for clever and industrious young men in Economic Zoology, students will be attracted to the University, who are in a position to take the full four years course without public assistance. It is also probable that in some of the Universities fellowships and scholarships may be endowed for the special purpose of the encouragement of agricultural research, and it may reasonably be expected that some of these may be available for the fourth year student in Economic Zoology. It is very unlikely that, at any time, the number of students in a single University will be a very large one, and it is certainly not desirable that the ranks should be overcrowded. The demand, therefore, for additional financial assistance need never be more than a very moderate one, but I am convinced that it must be made if the country is to be provided with the services of the minimum number of professional men that it obviously needs.

The relation of the modern University to the subject of Economic Zoology appears to me to be in the first place that of the Institution that provides the professional training of professional men. It may not be able to provide the whole of the training in this subject any more than a University can provide the whole of the training that is necessary for a medical man. There must be the same kind of association or co-operation between the University and some agricultural college in the neighbourhood as there is between the University and the hospital. But it is to the University that we must look for the systematic organisation of the courses of study, for the conduct of the examinations, and for the award of diplomas and degrees.

But the question arises whether this should be the only relation between the University and the subject. Should the staff of the University, in addition to their functions as the teachers of students, undertake the duties of consultants and advisers on questions of economic zoology that may arise in connection with the industries of the surrounding country. At the present time the members of the staff of the Manchester University and of the Manchester Museum are frequently consulted about the animal pests that appear in the farms, gardens, warehouses, and factories of the surrounding district, and, so far as possible, the pests are identified and suggestions are made as to the best means of combating the trouble.

In the initial stages of a School of Economic Biology there is an obvious advantage in the conduct of this branch of work. It enables the University and its Museum to complete their collections of the more frequent pests of the district, and it gives the University staff information as to the localities in which certain pests may be

most successfully searched for if they are wanted at any time for original investigation.

But I do not regard the "general practice" of Economic Biology, if I may use an expression borrowed from the medical profession, as strictly the function of a University. Such practice should be in the hands of specially qualified individuals appointed by the public authorities or of a department of the public institutions, which are specially concerned with agriculture and the public health.

The position of the University should be that of the consultant rather than that of the practitioner. In the economic laboratories or in the museum associated with the University, there should be a collection, as complete as possible, of specimens of economic importance both British and foreign. This collection should be consulted by the local practitioners when anything rare or unusual makes its appearance. The University should also be the seat of a library of Economic Biology as complete as possible in standard works and periodicals, and this library should be open to consultation by those engaged in economic work. But lastly, the University should have a small staff of teachers and a number of post-graduate scholars actively engaged in special investigations, and from them information should be procurable as to the latest and most efficient methods of investigation and treatment.

It will probably be some years before the Manchester University will be free from the self-imposed duty of making free identifications and giving free advice to all comers, but the burden of this duty is increasing year by year, and threatens in the near future to interfere to a material extent with what we may regard as the more legitimate functions of the University, the teaching of students, and the prosecution of original investigation.

In the preceding remarks I have referred to the subject of Economic Zoology as one that deals mainly with the animal pests of the farm, of the cattle yard, of the forests, and of human habitations, but there is another branch of the subject which I believe to be a very important one, and one that demands some words of reference in this paper. The great municipal corporations of this country are now engaged in two great enterprises: The provision of a good water supply and the disposal of sewage. Both of these enterprises involve problems of Economic Biology.

The main source of the water supply is usually some great lake or a series of artificial reservoirs in a distant mountainous country, and the water is conducted by closed pipes, many miles in length, to local reservoirs that feed the supply pipes. Chemical and

bacteriological analyses of the water are made, and, speaking generally, the supply is efficient and satisfactory. But from time to time various troubles arise which may give rise to what are called water-scares, such as the unpleasant smell in the water at Burnley in 1895, caused by *Limnaea peregra*, and the water-scare at Edinburgh in 1906. These troubles are in nearly all cases caused by different forms of animal life, sponges, polyzoa, molluscs, and crustacea. But so far as my information goes there has not yet been made any systematic biological analysis on a great scale of the sources of the water supply. There have, it is true, been some short papers published on the fauna and flora of the lakes, but a systematic and intensive study of the nature and periodicities of the plankton is still wanting, and until this is done we are not in a position to deal very satisfactorily with the biological difficulties which confront the water engineers. We meet with similar, but different problems, in connection with the disposal of sewage. In the outflow waters various species of animals are found—fresh-water mussels, leeches, worms, crustacea and protozoa. Some of these, such as the so-called sewage fungus—a species of *Epistylis*—are of considerable importance, and require careful investigation by competent and properly-trained biologists. But at the present time these problems are left in the hands of the chemists and bacteriologists, and very little progress is made towards their solution.

I should like to see the problems of animal and vegetable life in the sewage outflow of large towns the subject of an elaborate investigation, because there is every reason to believe that the result would be of great economic importance.

The investigation of these problems should be submitted to men who have had suitable training in Biology, and such men deserve as well as any other the designation of Economic Biologists. But for such men the training required should be on somewhat different lines to that provided for the Economic Biologists who deal with agricultural and public health problems. They need a special training in the methods of plankton research and a more detailed knowledge of such groups of animals as the fresh-water Protozoa and Algae, the Mollusca and Entomostraca. Such a training can only be given in the Universities working in conjunction with such an institution as the Sutton Broad laboratory, at present the only fresh-water biological station in the country.

A great many years may elapse before this branch of Economic Zoology will be duly recognized, and it would not be fair to encourage a student to take up this particular study with any hope

of obtaining permanent employment as an expert. But I believe the time will come when the services of such men will be required, and it might be well if the University teachers would bear this line of economic work in mind when they make their recommendations for special study or research to their students. Having sketched out in this paper a scheme for the teaching of Economic Zoology in the Universities, a word may now be said about the teaching of Economic Botany. The problem appears to me to be a very similar one in the two subjects. The subjects studied in the first year should be the same for the botanists as for the zoologists. In the second year, in addition to a full course in Botany, it is desirable that at least a short course on systematic zoology should be taken. As regards the details of the course in the third year I do not pretend to speak with authority, but I presume that special classes in vegetable Physiology and in the morphology of the Fungi will be necessary. The same need for some financial assistance to enable students to spend at least one post-graduate year in research will be felt in the botanical as in the zoological departments.

I hope it will not be long before courses of study for Economic Biologists, such as I have drawn up, are offered by several of the English Universities, and that they will meet with some small but encouraging success. When this is done we may trust that the sciences included in the term Economic Biology will make rapid progress in this country, and that a more scientific and better organized system for dealing with animal and vegetable pests will be found.

PRELIMINARY STUDIES ON THE BIOLOGY OF THE BEDBUG, *CIMEX LECTULARIUS*, LINN.

I. The Effect of Quantitatively Controlled Food-supply on Development.

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Introduction.

Quantitative studies on an insect of this kind made by an individual must necessarily be limited because of the time and care required to carry them on. The following studies, the first of which are included in the present paper, are designed to be carried on over a series of successive years, in order to make known as much as possible the actual biological facts in its life-history, and further to serve as an aid to those investigators who may desire to study the insect purely from the standpoint of its pathogenic relations. The bedbug is an exceedingly easy insect to rear; artificial laboratory conditions are more or less similar to its natural habitat, and its adaptability, hardiness, and longevity make it very pliable to the will of the experimenter.

As these studies are made at odd hours, subject to interruption, no excuse is needed for any shortcomings which they may have.

Purpose.

The purpose of the studies included in the present paper is to show how an approximately quantitatively controlled food-supply affects the rate of development. Two distinct generations were reared to maturity on human blood, each being divided into an experiment lot and a control lot. Both lots were fed at the same time, with this difference, the individuals of the control lot to repletion, but those of the experiment lot allowed to take approximately but one-half the blood for engorgement (satisfaction), always being interrupted at this point and not allowed food again until the next meal. The experiment consisted, therefore, primarily of disturbance before engorgement or repletion; in other words, the individuals of the experiment were not allowed to glut themselves as they naturally do, and as those in the control lot did, and hence it is to be inferred that the needs of the animals for food was not satisfied. This inference is borne out by the results.

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Laboratory Methods.

(*a*) *Method of Feeding; Conditions of the Experiment.*

As experience has shown that the individuals of this species vary considerably in regard to their capacity for food and in regard to the time taken for engorgement, it was found impracticable to control the quantity of food by using mechanical standards, so that engorgement, or satisfaction, was taken as the index of the optimum supply, and the food given to the individuals of the experiment was regulated accordingly. The individuals of the experiment were allowed to feed until swollen with blood, but in every instance were interrupted before engorgement or before the bug left the food of its own free will; and usually at approximately the half-way point. Normally, in all stages, the bedbug at any single meal feeds to repletion; during the meal, however, it has seemingly reached its capacity in about half the time actually required for satisfaction or repletion; that is, if the individual requires six minutes for repletion, the body is much more swollen and seemingly unable to hold more after about three minutes; but the bug continues to suck in more food and to expand until the longer period is completed. It was my aim at each meal, in the case of the individuals of the experiment, to prohibit feeding after this period of apparent capacity had been reached.

(*b*) *Apparatus Used; Procedure.*

All of the individuals used in this experiment, immediately after birth, were confined separately in small glass vials (37 mm. long, 9 mm. wide) stopped with cotton, and each containing a narrow strip of paper containing the number of the insect, and as well affording a support for it. The vials were placed within a tight, screw-capped tin cylinder (8.7 cm. long, 3.5 cm. wide), where they were constantly kept, excepting during the short periods of feeding. All of the animals were therefore in a similar environment, subjected to the same degrees of temperature, the same intensity of light, the same moisture content, and so on. This being true, all factors save those of the experiment, may be ignored.

In feeding the bugs, the vials were taken from the cylinder, and laid side by side on a table; the individuals of the control lot were then fed successively, followed similarly by those of the experiment; the vials were then returned to the cylinder. Each bug was fed singly by giving it access to a portion of the skin along the lower fore arm, usually accomplished by removing the cotton plug and placing the mouth of the vial against the skin, at the same time

inverting it; in this way, the narrow strip of paper in the vial afforded a support to the bug, which after response to the stimulus, simply ran down the inclined plane and inserted the setae into the skin.

It was the aim to feed the nymphs of the single generations at different periods of time, usually following ecdysis, but this was not regularly adhered to, from necessity.

Results of the Experiment.

The following table (Table I.) shows the differential of development in a generation of ten individuals, the progeny of a partly fed female bug captured in a state-room of a river steamboat, *en route* from Cincinnati, Ohio, to Louisville, Kentucky. The female was captured at 11.30 p.m., August 7th, 1907, and was immediately confined in an ordinary physician's pill-box and left there unfed. She died on August 26th after depositing the ten eggs which gave rise to this generation. The nymphs were confined, as previously stated, and kept at usual house temperatures for the season of the year. This generation was at first kept in the field laboratory of the Bureau of Entomology at New Richmond, Ohio, were later removed to a room in a hotel at that place, and on November 18th, 1907, they were transferred to Washington, D.C.; on December 27th to Chicago, Illinois, and on January 1st, 1908, to Urbana, Illinois. During these trips, and a few shorter ones, they were for brief intervals exposed to natural temperatures, being carried in a suit case. The tight tin tube in which the confining vials were kept, made this method of transportation without danger of infesting one's personal effects, pullman cars, hotels, and so on.

In this generation Lot I. was the control lot, Lot II. that of the experiment.

In Table II. the differential development of a generation of two (2) individuals of *lectularius* is shown. This generation, consisting of the control lot of four individuals, originated from an adult of a second bred generation from the original female parent of the generation recorded in Table I. Hence, it represents a third inbred generation which hatched from the four eggs at the average time of 8.15 p.m., April 21st, 1908. The recently born nymphs were immediately confined, as were the previous ones, and given their first meal just about twenty-four hours later. In this generation the actual time for each meal is recorded in addition to the other factors involved.

Lot II. Experiment; food-supply b

Stadium No.	No. 1 – ♂. Months	Meals	Days	Hours	No. 2. – – Months	Meals	Days	Hours	Months	No. 3 Meals
First.	11 p.m. Sep. 8	4-30 p.m. Aug 28 3 p.m. Sep. 1 4 p.m. Sep. 3 a.	12	11	11 p.m. Sep. 7	4-30 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3 a.	11	11	10 p.m. Sep. 7	4-30 p.m. Au 3 p.m. Sep 3 p.m. Sep a.
Second.	9 p.m. Sep. 30	8 p.m. Sep. 12 9 p.m. Sep. 17 8 p.m. Sep. 21 3 p.m. Sep. 23 a.	21	22	7 a.m. Sep. 22	8 p.m. Sep 12 9 p.m. Sep. 17 a.	14	8	4 p.m. Sep. 30	8 p.m. [redacted] 9 p.m. Sep 8 p.m. Sep 3 p.m. Sep a.
Third.	9 p.m. Nov. 1	3 p.m. Oct. 2 3 p.m. Oct. 4 8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 a.	32	0		3 p.m. Sep. 28 3 p.m Sep. 26 3 p.m Oct. 2 3 p.m. Oct. 4 8 p.m. Oct. 8 3 p.m. Oct. 10 a. 8 p.m. Oct. 23 a 11 a.m. Nov. 24 c a. a. d.			11 a.m. Nov. 15	3 p.m. Oct 3 p.m. Oct 8 p.m. Oct 3 p.m. Oct 4 p.m. Oct 8 p.m. Oct 10 p.m. No
Fourth.	7 p.m. Dec. 18	a (10 p.m. Nov. 1) 11 a.m. Nov. 12 11 a.m. Nov. 24 Noon, Dec. 1 4 p.m. Dec. 8 a.	46	22					Noon, Dec. 26	11 a.m. Nov Noon, Dec a. 4 p.m. Dec ad.
Fifth.	9 p.m. Jan. 9 (1908).	11 p.m. Dec 22 3 p.m. Dec. 29 a.	22	2					6 p.m. Jan. 17 (1908).	3 p.m. Dec 8 a.m. Jan 9, 10 a.m. Jan
Adult.		Length – 3.7 mm.								Length – 4.0
Sums:	5	18	135	9					5	20

Avg. Duration Cycles:	139.09 days	
,, No. Meals:	18.75	
,, No. Eedyses:	5.25	

a. Refused food at the time designated for the meal.
b. Died August 30, 1907.
c. Very pale before this meal.
d. Refused to feed: accidentally killed. Very small, pale and thin; in warm room. (Dec. 15, 1907).

ly below mum and abnormal.

3 — ♀		No. 4 — ♀			No 5. — ♂			Ecdysis No.
eals	Hours	Moults	Meals	Days	Hours	Moults	Meals	Days	Hours	
ı. Aug. 28 . Sep. 1 . Sep. 3 a.	10	10 p.m. Sep. 7	4-30 p.m. Aug. 28 3 p m. Sep. 1 3 p.m. Sep. 3 a.	11	10	7 a.m. Sep. 2	4-30 p.m. Aug. 28 a.	5	19	1
12 Sep. 17 Sep. 21 Sep. 23 a.	18	7 a.m. Oct. 1	8 p m. Sep. 12 9 p.m. Sep. 17 8 p.m. Sep. 21 3 p.m. Sep. 23 a.	23	9	5 a.m Sep. 18	3 p.m. Sep. 3 8 p.m. Sep. 6 8 p.m. Sep. 12 a.	15	22	2
. Oct. 2 Oct. 4 . Oct. 8 Oct. 10 Oct. 17 Oct. 23 . Nov. 1	19	2 p.m. Nov. 4.	3 p.m. Oct. 2 a. 8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 8 p.m. Oct. 23 10 p.m. Nov. 1	34	7	Noon, Oct. 3	9 a.m. Sep. 18 3 p.m. Sep. 23 3 p.m. Sep. 26 a.	15	7	3
Nov. 24 Dec 1 ı. Dec. 15 d.	1	7 p.m. Dec. 10	11 a.m. Nov. 24 Noon, Dec. 1 a.	36	5	3 p.m. Dec. 4	8 p.m. Oct. 8 3 p.m. Oct. 10 4 p.m. Oct. 17 8 p.m. Oct. 23 10 p.m. Nov. 1 11 a.m. Nov 24 a.	62	3	4
Dec. 29 n 9, 1908 Jan. 12	6	11 a.m. Jan. 7	4 p.m. Dec. 15 11 p.m Dec. 22 3 p.m. Dec. 29	27	16	7 p.m. Jan. 8 (1908).	4 p.m. Dec. 8 4 p.m. Dec. 15 11 p.m. Dec. 22 3 p.m. Dec. 29 a.	36	4	5
-4.0 mm.		11 p.m. Jan. 16	8 a.m. Jan 9, 1908 10 a.m. Jan. 12 e. Len'h – 4.20 mm.	9	12		Length – 4.0 mm.			6
0	6	6	20	142	11	5	17	135	7	

ad. Ref : timid.
e. An tional stadium.
f. Th determinations were made by direct observation when possible, confirmed by secondary characters in the female, noticeable in the figures of some authors, particularly noticed and discussed by Ribaga (1897).

TABLE I.

Effect of Quantitatively controlled food-supply on the rate of development of 1 generation of 5 individuals of Cimex lectularius, Linn.
Lot I. = Control. Lot II. = Experiment. Ten (10) individuals, hatching August 27th, 1907, noon.

Lot 1. Control; food-supply optimum and normal.

Stadium No.	No. 1. ♀ I.			No. 2. ♀			No. 3. ♂		No. 4. ♀			No. 5. – –			Feeds No.
	Month	Meals	Days	Hours	Month	Meals	Days	Hours	Month	Meals	Hours	Month	Meals	Days Hours	
First.	7 a.m. Sep. 2	4 p.m. Aug. 28 a.[4]	5	19	10 p.m. Sep. 3	4 p.m. Aug. 28 3 p.m. Sep. 1 3 p.m. Sep. 3	12	10	8 p.m. Sep. 4	4 p.m. Aug. 28 a. a.	8	6 a.m. Sep. 2	4 p.m. Aug. 28 a.	5 18	4 p.m. Aug. 28 b.	1
Second.	Noon Sep. 10	3 p.m. Sep. 3 a.	8	5	3 p.m. Sep. 17	8 p.m. Sep. 12	8	18	4 p.m. Sep 10	10 a.m. Sep. 5 8 p.m. Sep. 6	20	5 p.m. Sep. 10	3 p.m. Sep. 3 8 p.m. Sep. 6	8 14		2
Third.	4 p.m. Sep. 20	8 p.m. Sep. 12 9 p.m. Sep. 17	10	4	3 p.m. Sep. 23	9 p.m. Sep. 17 a.	4	23	6 p.m. Sep. 23	8 p.m. Sep. 12 9 p.m. Sep. 17	2	5 p.m. Sep. 17	8 p.m. Sep. 12	6 21		3
Fourth.	2 p.m. Oct. 1	8 p.m. Sep. 21 3 p.m. Sep. 23 a.	10	22	6 a.m. Oct. 4	3 p.m. Sep. 23 3 p.m. Sep. 26 a.	11	15	4 p.m. Oct. 3	a. 3 p.m. Sep. 23 3 p.m Sep. 26 a.	22	7 a.m. Sep. 23	9 p.m. Sep. 17 a.	5 14		4
Fifth.	Noon Oct. 30	3 p.m. Oct. 2 3 p.m. Oct. 4 a. a. a. a.	28	22	6 p.m. Nov. 10	a. 8 p.m. Oct. 8 a. a. 8 p.m. Oct. 23 10 p.m Nov. 1	46	11	4 p.m. Nov. 6	3 p.m Oct. 4 8 p.m. Oct. 8 a. 4 p.m. Oct. 17 8 p.m. Oct. 23 a.	0	8 p.m. Oct. 23	a.(5 p.m. Sep. 24) a. 3 p.m. Oct. 2 a. a. a. a.	30 11		5
Adult.	Length – 4.5 mm.				Length – 5.0 mm.				Length – 4.5.			Len'h – 4.35 mm.				6
							11	4	5	6	57	0				

TABLE II.

Effect of Quantitatively controlled food-supply on the rate of development: a generation of 2 individuals of Cimex lectularius, Linn. Four (4) individuals hatching at the average time of 8 p.m., April 21st, 1908.

Stadium No.	Lot No. I.—Optimum. No. 1 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	No. 2 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	Lot No. II.—Half-supply or below Optimum. No. 1 – ♂ Moults	Hours	Meals: Time of b.	Meals: Duration, minutes.	No. 2 – ♂ Moults	Days	Hours	Meals: Time of b.	Meals: Duration, minutes.	Eggs
First.	1 p.m. Apr. 30	4	17	8:33 p.m. Apr. 22 a.	4	1 p.m. Apr. 26	4	20	8:33 p.m. Apr. 22 a (9:30 p.m. Ap. 25)	5	1 p.m. Apr. 27	5	12	8:33 p.m. Apr. 22 a	1½	11 p.m. Apr. 26	5	3	8:33 p.m. Apr. 22 a.	1½	1
Second.	7 a.m. May 3	6	18	8:55 p.m. Apr. 27	4¾	10 p.m. May 3	7	6	9:05 p.m. Apr. 27	3½	May 10. e	0	9:15 p.m. Apr. 27 9:10 p.m. May 4	2 3¾	May 10. e	14	0	9:10 p.m. Apr. 27 9:05 p.m. May 4	1½ 2¼	2
Third.	May 10. e	7	0	8:45 p.m. May 4	9½	May 10. e	7	0	8:30 p.m. May 4	6½	10 a.m. June 28	1	10 p.m. May 27 11:05 p.m. June 22 f.	3½ 4	Noon June 3	22	18	10:10 p.m. May 27	4	3
Fourth.	11 a.m. June 4	25	4	9:40 p.m. May 27	8½	7 p.m. June 3	23	21	10:20 p.m. May 27	40 c	10 p.m. July 10	18	10:22 p.m. July 4 10:06 p.m. July 15	3¾ 3	11:30 a.m. June 30	27	23½	10:45 p.m. June 22 g.	4½	4
Fifth.	8 p.m. June 30	25	9	11 p.m. June 22	9½	2:40 p.m. June 30	26	19½	10:30 p.m. June 22	20 d	Aug. 15	0	10:03 p.m. July 22 9:43 p.m. Aug. 9	8¼ 6¾	July 21	21	1½	10:22 p.m. July 4 9:57 p.m. July 15	3¾ 3	5
Sixth.															Aug. 17	27	0	9:55 p.m. July 22 9:50 p.m. Aug. 9	3 3	6
Adult.																				
Sums:	5	70		5	36.5	5	69	18.75	5	75	5	6	9	91	6	117	17	9	26.5	
Averages		14		1	7.3		13.95		1	15		2	1.8	3.4		19.6		1.5	2.9	

Average No. of Ecdyses: 5 — 5.5

" Duration of Cycles: 69.87 days — 116.9 days

" No. number of meals per lot: 5.

Interpretation of the Results.

Primarily, it is obvious from the tables that the individuals of the experiment did not obtain enough nourishment, from the amount of food allowed them, to develop at a normal rate; in other words, for normal development, the insect requires to feed to repletion. Furthermore, it is shown that if glutted or fed to repletion once in each stadium, normal development occurs, though the insect will take additional meals in any one stadium after an interval of several days. After the individuals of the experiment came to maturity, some of them were fed to repletion and mated, and reproduction occurred normally with them. The reduced quantity of food, therefore, did not affect reproduction or sex, but lengthened the cycle indefinitely, reduced their size, and increased the average number of ecdyses. The most noticeable effect produced was the lengthening of the cycle. It is well to record here the fact that adult males feed as do the females, but are not as strongly stimulated when exposed to a host, and are more cautious in approaching it after response to the stimulus.

Literature Referred To.

Ribaga, Constantino.—Sopra un organo particolare delle Cimici dei letti (*Cimex lectularius*, L.) Revista di Patologia Vegetale, Portici, 1897, v, pp. 343-352, pl. xvi, figs. 1-3, text-figs 1-4. Separate, Portici, May, 1897.

SOME REMARKS ON THE PARASITES OF THE LARGE LARCH SAWFLY, *NEMATUS ERICHSONII.**

By

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THE serious nature of the attacks of *Nematus erichsonii* in the Lake District are now well known, and although it is not practicable to efficiently control the pest outside the plantations of young larches, yet, owing to the work of Dr. Hewitt, it is known that its natural enemies render great services; the small field vole destroying quantities in the cocoons during winter, and various species of birds devouring the larvae on the trees in summer. The efforts to attract these useful birds to the district which are being carried out on the Thirlmere estate by the Manchester Corporation, are meeting with increasing success, half the boxes being occupied during the last summer. Some 280 nest-boxes are now suspended in these woods.

It is evident that a more or less complete destruction of the larches such as has taken place in certain extensive plantations will become general throughout the affected areas if the parasitic enemies of the Sawfly fail to increase to such an extent as to be able to cope with the attack. By far the most important parasite of *Nematus erichsonii* as yet recorded in this country is the ichneumon *Mesoleius aulicus*, Grav. In 1908 this species was present in hardly 6 per cent. of the Sawfly cocoons collected from various plantations in the Lake district, but in 1909 this proportion had increased to 15 per cent. During the present summer the number of these ichneumons had increased beyond all anticipations, some 62 per cent. of the cocoons from the same areas being parasitized. This ichneumon has been previously recorded as parasitising *Nematus croceus*, a Sawfly feeding upon the willow. It is impossible to at all accurately determine the number of larvae parasitized by a single ichneumon, but in the ovaries of individuals kept in captivity there were usually some thirty, and in cases as many as forty, mature eggs. About .3 per cent. of the cocoons furnished specimens of the ichneumon *Microcryptus labralis* this year. It was thought that this species was a hyper-parasite of *Mesoleius aulicus*, but, as it was present to the extent of some 16 for every 1,000 of the

* Read before the Association of Economic Biologists, Manchester Meeting, July 7th, 1910.

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latter during 1909, and only to the extent of 5 for every 1,000 during the present summer, this is unlikely. Another species of ichneumon was discovered this year emerging from two per cent. of the cocoons. It is possible that this is a hyper-parasite, though from the fact that *Mesoleius aulicus* transforms within the stout cocoon of *Nematus erichsonii*, and underneath the turf, it is not so liable to suffer from such. This species can be readily distinguished from *Mesoleius aulicus* by the white colour of the first and second coxae, and the dark tint of the third. With a lens it is seen that the face in the female is marked with white, and that in the male the white marking present in both species is broader than in *M. aulicus*. The base of the antennae in both sexes is tinged with white in front. The eggs evidently take some time to ripen, but some hundred eggs seemed capable of reaching maturity in the ovaries of this species. A specimen of still another species of ichneumon, with white bands in the middle of the antennae, was observed to emerge from the cocoons.

Complete investigations of the behaviour of the parasites of insect pests during periods of abnormal multiplication of their hosts are wanting, and the relative value of the several factors concerned in the checking of the undue extension of harmful species is usually a matter of conjecture. Notwithstanding this, such facts as are available allow of some conclusions being drawn from the observations made upon the parasites of the Larch Sawfly. The observations of Dr. L. O. Howard upon the white marked Tussock Moth, furnish an instance of the extreme thoroughness with which the parasites of a tree feeding caterpillar may be capable of doing their work. By the end of August, 1895, the caterpillars of this Tussock Moth had defoliated almost every poplar, soft maple, box elder, elm, alder, birch, and willow in the City of Washington, but the ichneumon and chalcid parasites had by this time so increased that they had parasitized 90 per cent. of the larvae. The eggs of the surviving moths hibernated, and the caterpillars of the first brood were parasitized to the extent of 98 per cent. In June it was a very difficult matter to get living individuals for rearing experiments. Hyper-parasites exerted an appreciable effect upon the parasites of the late brood, the larvae of the moth being in consequence a little less difficult to obtain than in June.

It was not to be expected that the parasites of the Larch Sawfly would increase in such rapid fashion and to the extent that was observed in the case of this Tussock Moth; nevertheless, it is reassuring to find that such an effective parasite as *Mesoleius aulicus* exists, and from the large percentage of cocoons parasitized it is extremely

likely that a perceptible lessening in the severity of the attack will be experienced this summer in the Thirlmere plantations. Moreover, owing to the fact that this ichneumon pupates beneath the turf within the cocoon of the Large Larch Sawfly, it is not so exposed to the attacks of hyper-parasites as in the case of the parasites of the white-marked Tussock Moth, and hence its effectiveness is not likely to be diminished by such agency.

That the small field vole, the birds, the fungus parasite, and the other insect parasites seriously check the multiplication of *Mesoleius aulicus*, wherever the proportion of larvae parasitized by the latter is considerable, is quite possible, but the results of such interference must be clearly distinguished from the effects of hyper-parasitism. The activity of the hyper-parasite leads to a direct reduction in numbers of its parasitic host. Primary parasites and the various natural enemies may, by constantly involving one another in mutual destruction, lower the efficiency of each separate factor concerned in checking the pest, but their combined activities will always produce a higher mortality than could result from the unhampered efforts of any single species, so that as a general rule it is advisable to encourage as far as practicable all the primary parasites and natural enemies. Although it is too much to look forward to more than a partial and perhaps inconsiderable alleviation of the severity of the Larch Sawfly attack during the present summer, yet it can be anticipated with much confidence that during next season the larches in the vicinity of Thirlmere will present a very much more favourable aspect than during the past few years.[1]

A Tachinid which was observed to emerge from the cocoons this season proved to be *Exorista dubia*. The fungus *Cordyceps*, sp., seemed to be slightly more prevalent, this year accounting perhaps for some 10 to 15 per cent. of the larvae.

The parthenogenetic origin of the vast majority of the Sawfly larvae was again evident as hardly more than .2 per cent. of the Sawflies emerged were males.

[1] A thorough inspection of the larch plantations at Thirlmere, during August of the present year, revealed a most marked improvement in the condition of the trees. The brown aspect of the older woods, such a conspicuous feature in previous years, was not at all in evidence, and even in young and unsprayed plantations it was very exceptional to meet with completely defoliated trees. That the greatly diminished numbers of the Larch Sawfly are not to be attributed to meteorological conditions is perhaps demonstrated by the fact that at Grasmere, only some five miles to the South, the larches, conspicuously attacked for the first time last year, are this summer as brown as possible. There can be little doubt but that *Mesoleius aulicus* is the chief, if perhaps not the only factor, in this diminution, and it now remains to be seen to what extent it will exert its controlling power in subsequent seasons.—[J. M.].

THE APTERYGOTA OF HERTFORDSHIRE.

By

WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.,

AND

JOHN W. SHOEBOTHAM, N.D.A.

With Figures 1-15.

Introduction.

The number of papers dealing with the distribution of the Apterygota of the British Isles are very few, indeed, apart from a comprehensive account of the Collembola and Thysanura of the Edinburgh district by Carpenter and Evans (20), and a preliminary list of those of the Midland Plateau by one of us (25), no one has dealt with our British species in any detail since the publication of Lubbock's Monograph thirty-seven years ago.

Our object in issuing the present communication is to place in the hands of entomologists a record of our work on the Apterygota of Hertfordshire, a county rich in these interesting insects, and to give short descriptions of the chief specific characters as an aid to identification, together with figures of the leading structural characters of some of the species.

Carpenter and Evans (20) enumerate 4 species of Thysanura and 59 species of Collembola; in the present paper 4 species of Thysanura and 69 species of Collembola are recorded.

Previous Records of Apterygota from Hertfordshire.

So far as we are aware, there were no records of Apterygota from the county of Hertfordshire till we commenced our work on them.

We give a list of the species we have recorded up till now (left hand column), together with the names under which they are recorded in this paper (right hand column).

Curiously enough the first two papers were both published on the same day (April 23rd, 1909).

[Journ. Econ. Biol., Oct., 1910, vol. v, No. 3.]

Collinge and Shoebotham (26).

Sminthurus biflavopunctatus	...	Sminthurinus fenestratus.
Sminthurus aureus ...	...	Sminthurinus aureus.

Shoebotham (67).

Collembola.

Anura muscorum ...	...	Neanura muscorum.
Entomobrya albocincta ...	...	Entomobrya albocincta.
Isotoma palustris ...	...	Isotomurus palustris.
Isotoma viridis	...	Isotoma viridis.
Lepidocyrtus cyaneus ...	...	Lepidocyrtus cyaneus.
Orchesella cincta ...	...	Orchesella cincta.
Orchesella villosa ...	...	Orchesella villosa.
Tomocerus vulgaris ...	...	Tomocerus vulgaris.
Sminthurus aquaticus ...	...	Sminthurides aquaticus.

Thysanura.

Campodea staphylinus ...	...	Campodea staphylinus.
Lepisma saccharina ...	...	Lepisma saccharina.

Collinge and Shoebotham (27).

Amerus normani	...	Megalothorax minimus.
Neelus murinus	...	Neelus murinus.

Collinge and Shoebotham (28).

Pseudachorutes subcrassus	...	Pseudachorutes subcrassus.
Achorutes neglectus ...	...	Achorutes manubrialis var. neglecta.
Isotoma binoculata ...	...	Folsomia quadrioculata var. diplophthalma.
Isotoma minor	...	Isotoma minor.
Neelus murinus	...	Neelus murinus.
Sinella höfti	...	Sinella höfti.
Sinella curviseta	...	Sinella curviseta.
Lepidocyrtus sexoculatus ...	...	Lepidocyrtus sexoculatus.
Pseudosinella alba ...	...	Lepidocyrtus albus.

Economic Importance.

Although this paper is entirely of a systematic nature, it must not be forgotten that certain of the Collembola are injurious to farm and garden crops. The economic aspect has recently been treated of by Carpenter (19), and Collinge (22, 24). Professor Carpenter (19, p. 15), says:—

"No worker at applied science should be discouraged from the study of any branch of knowledge because it seems to have no direct bearing on economic work. The systematic study of Collembola would have been regarded as waste of time by the severely practical man a few years ago. But he cannot afford to neglect it any longer."

Our thanks are due to Professor F. Silvestri and Dr. Carl Börner for assistance and kind criticism.

To the Council of the Birmingham Natural History and Philosophical Society we are indebted for the loan of figures 6, 7, 9, 10, and to Miss O. B. Bagnall and Mr. E. Popple for specimens of Apterygota. Miss Bagnall has collected Collembola and Thysanura from Kimpton, near Welwyn, and all specimens recorded from that locality were taken by her. Mr. Popple has collected three of the species of Thysanura.

Except for the above, all the specimens here recorded have been collected by us, chiefly in Berkhamsted or close to the town.

Sub-Class APTERYGOTA, Oudemans.
Order THYSANURA, Latr, Lubb.

Family CAMPODEADAE, Lubb.
Genus **Campodea**, Westwood.

In examining our specimens of the genus *Campodea*, we noticed two types, differing in the length and hairing of the cercopods, and thought that possibly they represented separate species. Prof. Silvestri, to whom we submitted specimens, thought there were probably two species, but could not say for certain owing to the small number and broken condition of the specimens.

1.—**Campodea staphylinus**, Westw.

Hab.—Berkhamsted, in greenhouse (E. Popple); in garden soil.

2.—**Campodea**, sp.

Hab.—Berkhamsted, in greenhouse; under stones.

Family LEPISMIDAE, Grassi.
Genus **Lepisma**, Linn.

3.—**Lepisma saccharina**, Linn.

Hab.—Berkhamsted, in pantry (1); in greenhouse (1) (E. Popple); in kitchen cupboard (common); Kimpton, Welwyn, in kitchen (2).

Family MACHILIDAE, Grassi.

Genus **Praemachilis**, Grassi.

4.—**Praemachilis italica** (Cor.), Silv.

? = *Praemachilis hibernica*, Carpenter.

Prof. Silvestri, who identified this species, is of opinion that it is identical with Carpenter's *P. hibernica*.

Hab.—Great Gaddesden, under a stone (1) (E. Popple); Berkhamsted, under a dry piece of wood (1).

Order COLLEMBOLA, Lubb.

Collembola, Lubbock, Notes on the Thys., pt. IV, 1870, p. 295.
Collembola, Lubbock, Monograph, 1873, p. 36.

Sub-order **Arthropleona**, Börn.

Arthropleona, Börner, Vorläuf. Mitth, über ein. neue Aphor., 1901, p. 5.
Arthropleona, Börner, Apterygoten-Fauna von Bremen, 1901, p. 12.

Family ACHORUTIDAE, Börn.

Achorutidæ, Börner, Vorläuf. Mitth. über einige neue Aphor. u. zur Syst. d. Coll., 1901, p. 12.

Sub-family **Podurinae**, Börn.

Podurinae, Börner, Das Syst. d. Coll., 1906, p. 160.

Genus **Podura**, Linn., Tullb.

Podura, Linné, Syst. Nat., Ed. II, 1740, p. 62.*
Podura, Tullberg, Förh. öfver Sv. Pod., 1871, p. 153.

1.—**Podura aquatica**, L., Nic.

Podura aquatica, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Podura aquatica, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 55.

Eyes, 8 on each side of the head. Upper claw long and slender, with 1 small inner tooth, without lateral teeth. Lower claw absent or rudimentary. Anal horns absent. Furcula long, reaching past the ventral tube. Dentes bow-shaped. Colour, back blackish, legs, antennae, and underside with a reddish tinge.

Hab.—Berkhamsted, on watercress beds (few); Waterend, on water of mill-pool (fairly common).

Sub-family **Achorutinae**, Börn.

Achorutini, Börner, Apterygoten-Fauna v. Bremen, 1901, p. 26.
Hypogastrurinae, Börner, Das Syst. d. Coll., 1906, p. 160.

* The * denotes that the reference has not been seen, but taken from other authors.

Genus **Achorutes**, Templ., Lubb.

Achorutes, Templeton, Thys. Hib., 1834, p. 96.
Achorutes, Lubbock, Notes on the Thys. pt. II, 1862, p. 591.

2.—**Achorutes viaticus** (Linn.), Tullb.

Podura viatica, Linné, Fauna Suecica, Ed. I, 1746, p. 343.*
? *Achorutes dubius*, Templeton, Thys. Hib., 1834, p. 96.
Achorutes murorum, Tullberg, Skand. Pod. underf. Lipur., 1869, p. 7.
Achorutes viaticus, Tullberg, Sver. Pod., 1872, p. 50.
? *Achorutes dubius*, Lubbock, Monograph, 1873, p. 178.
Achorutes murorum, Lubbock, Monograph, 1873, p. 182.

Eyes, 8 on each side of the head. Upper claw with an inner tooth a little beyond the middle (as in *purpurescens*), with a lateral tooth on each side near the distal end. Lower claw bristlelike, reaching to the tooth on the upper claw, with an inner lamella about half its length. All the legs with 3 clavate hairs. Anal horns more slender than in *purpurescens*, lightly curved, longer than the papillae on which they stand. Papillae separated at the base. Mucro with a broad, toothed lamella. Colour deep blue-black.

Hab.—Berkhamsted, about a rubbish heap where decaying Mangels had been thrown, amongst crevices in soil, and on water that had drained away (extremely common, being present in thousands); on garden footpath (common).

3.—**Achorutes purpurescens**, Lubb.

Achorutes purpurescens, Lubbock, Notes on the Thys., part III, 1868, p. 302.*
Achorutes purpurescens, Lubbock, Monograph, 1873, p. 181.

Eyes, 8 on each side of the head. Upper claw with strong inner tooth a little past the middle, with a lateral tooth on each side near the base. Lower claw bristlelike, reaching to the tooth on the upper claw, with broad inner lamella half its length. Front tibio-tarsus

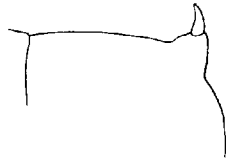

FIG. 1.—*Achorutes purpurescens*, Lubb. Abd. vi, from the side, showing anal horn.

with two, middle and hind with three clavate hairs. Anal horns thick, lightly curved, shorter than the papillae on which they stand. Papillae touching at the base.

Mucro with very narrow inner lamella, and a little broader outer lamella, two-thirds the length of the mucro. Colour dark purple, pigment mottled.

Hab.—Berkhamsted, common in greenhouse on flower-pots, underside of a fungus, under bricks and wood in a garden, and on water in a tank.

4.—**Achorutes armatus** (Nic.).

Podura armata, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 57.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth about the middle and 1 lateral tooth on each side near the base. Lower claw bristlelike with fairly broad inner lamella. Tibio-tarsus with 1 clavate hair, the end of which is only very slightly thickened. Dentes tapering. Mucro with large, toothed outer lamella. Anal horns long, slightly curved. Anal papillae touching at their bases.

Hab.—Berkhamsted, under sticks in a wood (common); under flower-pots in greenhouse (few); underside of a fungus (common); under bricks in a garden (few).

5.—**Achorutes rufescens** (Nic.).

Podura rufescens, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 57.

Eyes, 8 on each side of the head. Upper claw with a weak inner tooth. Lower claw bristlelike, one-third as long as the upper claw, with an inner lamella in the basal half. Tibio-tarsus with 1 clavate hair. Dens broader at the distal than the proximal end. Anal horns 2, short, almost straight. Colour reddish.

Hab.—Berkhamsted, on water in a cart rut (few).

6.—**Achorutes manubrialis**, Tullb.

Achorutes manubrialis, Tullberg, Skand. Pod. underf. Lip., 1869, p. 9.
Achorutes schötti, Reuter, Apt. Fenn., 1895, p. 31.
Achorutes manubrialis, Schött, Étud. s.l. Coll. d. Nord. 1902, p. 9.
Achorutes manubrialis, Ågren, Zur. Kennt. d. Apt. Süd-Schwed., 1903, p. 122.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth a little beyond the middle. Lower claw bristlelike, without lamella, reaching to the tooth on the upper claw. Tibio-tarsus with 1 clavate hair. Manubrium equal in length to the dens and mucro together. Dens twice as long as the mucro. Anal horns, 2, short, straight. Anal papillae separated. Colour reddish or dark blue.

Hab.—Berkhamsted, on water in a cart rut (4).

var. **neglecta**, Börn.

Anal horns and papillae absent.

Hab.—Berkhamsted, amongst short grass and on water in a cart rut (few).

Genus **Xenylla**, Tullb.

Xenylla, Tullberg, Skand. Pod. underf. Lip., 1869, p. 11.

7.—**Xenylla grisea**, Axels.

Xenylla grisea, Axelson, Vorläuf. Mitth. über ein. neue Coll. aus Finnland, 1900, p. 4.

Body slender. Eyes, 5 on each side of the head. Upper claw without inner teeth. Tibio-tarsus with 2 clavate hairs. Dens and mucro fused together. Mucrodens a little shorter than the manubrium but longer than the foot claw, with hooked end. Anal horns 2, fairly long, curved, standing on large papillae, which are separated at their bases. Colour, pale blue grey.

Hab.—Berkhamsted, under bark of rotting oak stick (fairly common); under bark of fence post (common).

This is the first record for this country.

Sub-family **Onychiurinae**, Börn.

Onychiurinae, Börner, Neue Coll. u. z. Nomen. d. Coll., 1901, p. 698.
Onychiurinae, Börner, Das Syst. d. Coll., 1906, p. 159.

Genus **Onychiurus**, Gerv., Börn.

Lipura, Burmeister, Hand. der Ent., 1838, p. 447.*
Onychiurus, Gervais, Écho du Monde savant, 1841.*
Onychiurus, Börner, Neue Coll. u. z. Nomen. d. Coll., 1901, p. 698.

8.—**Onychiurus fimetarius** (Linn., Lubb.).

Podura fimetaria, Linné, Syst. Nat., Ed. XII, 1766.*
Lipura inermis, Tullberg, Skand. Pod. underf. Lip., 1869, p. 18.
Lipura fimetaria, Lubbock, Monograph, 1873, p. 191.
Lipura wrightii, Carpenter, Coll. of Mitch. Cave, 1897, p. 230.

Eyes absent. Pseudocelli of the *armata* type. (Börner, 6, p. 20). Antennal base with 2 pseudocelli and 1 just outside the Ant. base. Hind edge of the head with 2 on each side. Postantennal organ with 14-16 circular granular tubercles. Upper claw without inner or lateral teeth. Lower claw bristlelike reaching to, or past, the end of the upper claw. Anal horns and papillae absent. End of Abd. VI. rounded.

Hab.—Berkhamsted, in cellar under flower-pots (few); on water in cistern (few); under board and flower-pots in greenhouse (fairly common); in loose soil (few).

9.—**Onychiurus ambulans** (Linn., Tullb.).

Podura ambulans, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Lipura ambulans, Tullberg, Skand. Pod. underf. Lipur., 1869, p. 17.
Lipura ambulans, Lubbock, Monograph, 1873, p. 189.

Eyes absent. Pseudocelli of the *armata* type (see Börner, 6, p. 20), 2 on each antennal base and 1 just outside the antennal base, hind edge of the head with 2 on each side. Postantennal organ of 12-14 circular granular tubercles. Upper claw without inner or lateral teeth. Lower claw bristlelike, reaching to the end of the upper. Colour white.

Hab.—Berkhamsted, under flower-pots in a cellar (few); amongst decaying leaves (few); under flower-pots in greenhouses (common); Kimpton, Welwyn, in greenhouse (common).

10.—**Onychiurus armatus** (Tullb.).

Lipura armata, Tullberg, Skand. Pod. underf. Lipur , 1869, p. 18.

Eyes absent. Antennal base with 3 pseudocelli, hind edge of the head with 3-4 on each side. Postantennal organ with smooth oval tubercles, generally 22-32, but some have more than this.

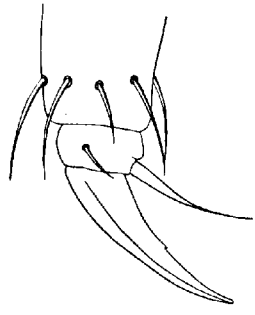

FIG. 2.—*Onychiurus armatus* (Tullb.). Foot, from the side.

Upper claw without lateral teeth, sometimes with one inner tooth. Lower claw bristlelike, reaching to the end of the upper. Anal horns, 2. Colour white.

Hab.—Berkhamsted, under board and flower-pots in a greenhouse (fairly common); under a board in a garden (few); under stones (few); Waterend, under a log of wood (1).

11.—**Onychiurus burmeisteri,** (Lubb.).

Lipura burmeisteri, Lubbock, Monograph, 1873, p. 190.

Eyes absent. Pseudocelli of the *tuberculata* type (see Börner, 6, p. 20), antennal base with 2, hind edge of the head with 0. Postantennal organ of 24-26 smooth, oval tubercles. Anal horns, 2, stout, curved. Skin granules much larger than other British species of *Onychiurus*. Colour creamy white.

Hab.—Berkhamsted, under logs of wood, boards and stones in gardens (very common); under flower-pots in greenhouses (fairly common); Kimpton, Welwyn, under a piece of wood (few).

This species is very distinct from *O. armata*. It seems to be confined to the southern and midland parts of England.

Genus **Tullbergia,** Lubb., Börn.

Tullbergia, Lubbock, New Gen. and Spec. of Coll. fr. Kerg. Isl., 1876.*
Tullbergia, Börner, Jap. Coll., 1909, p. 102.

12.—**Tullbergia krausbaueri** (Börn.).

Mesaphorura krausbaueri, Börner, Vorläuf. Mitth. über einige neue Aphor. u. zur Syst. d. Coll., 1901, p. 2.
Stenaphorura krausbaueri, Börner, Apterygoten-Fauna von Bremen, 1901, p. 24.

Body very slender. Eyes absent. Pseudocelli distributed as follows:—In front of postantennal organ 1, hind edge of the head 1 on each side, and 1 on each side of Th. II, III, and Abd. IV. The pseudocelli are of a peculiar type, each being composed of 6-7 tubercles arranged in a ring similar to some postantennal organs. Postantennal organ of 40-50 oval tubercles. Upper claw without inner or lateral teeth. Lower claw only present as a small bristle. Anal horns 2, short, slightly curved. Furcula and tenaculum totally absent. Colour white. Length 1 mm.

Hab.—Berkhamsted, under bark of rotting wood (few); under a brick lying on the ground in a small wood (few).

Sub-family **Neanurinae,** Börn.

Neanurinae, Börner, Über. ein neues Achorut. Willemia, 1901, p. 431.

Genus **Anurida,** Laboulb.

Anurida, Laboulbène, Rech. sur l'*Anurida maritima*, 1864.*

13.—**Anurida granaria** (Nic.).

Anoura granaria, Nicolet, Essai sur une classif. d. Ins. Apt. de l'ordre des Thys., 1847, p. 387.*
Anurida granaria, Tullberg, Skand. Podur. af underf. Lip., 1869, p. 20.
Anoura granaria, Lubbock, Monograph, 1873, p. 198.

Eyes absent. Pseudocelli absent. Postantennal organ of 14-16 oval tubercles arranged in a ring. Lower claw absent. Tibio-tarsus without clavate hairs. Skin granules large. Colour creamy white.

Hab.—Kimpton, Welwyn, in greenhouse under flower-pots (few); Berkhamsted, under sticks and stones lying in soft earth (fairly common); amongst soil in a greenhouse (few).

Genus **Friesea**, D.T.

Triaena, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 155.
Friesea, Dalla Torre.

Tullberg's name was pre-occupied and the genus was renamed by Dalla Torre.

14.—**Friesea claviseta**, Axels.

Friesea claviseta, Axelson, Vorläuf. Mitth. über ein. Neue Coll. aus Finnland, 1900, p. 8.

Eyes, 8 on each side of the head. Postantennal organ absent. Upper claw without inner teeth. Lower claw absent. Tibio-tarsus with 4-5 clavate hairs. Furcula short, mucrodens shorter than the manubrium. Abd. V and VI, with several long, clavate hairs. Abd. VI with 3 anal horns. Colour light grey-blue.

Hab.—Berkhamsted, under bark of oak stump (few); in greenhouse, under flower-pots (few).

This is the first British record of this species.

Genus **Pseudachorutes**, Tullb.

Pseudachorutes, Tullberg, Fört. öfver Sv. Pod., 1871, p. 155.

In a previous paper (28) we recorded the species *P. subcrassus* from this county and mentioned that we had also a second species. This we have identified with the *P. asigillatus* of Börner.

15.—**Pseudachorutes subcrassus**, Tullb.

Pseudachorutes subcrassus, Tullberg, Fört. öfver Sv. Pod., 1871, p. 155.

Eyes, 8 on each side of the head. Postantennal organ of 8-11 tubercles arranged in a ring. Upper claw with distinct inner tooth about the middle and 1 lateral tooth on each side slightly nearer the proximal end. Tibio-tarsus without clavate hairs. Anal horns absent. Colour pale blue-grey, underside lighter. Length, 1.8 mm.

Hab.—Berkhamsted, under bark of rotting wood (fairly common).

16.—**Pseudachorutes asigillatus**, Börn.

Pseudachorutes asigillatus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 36.

Eyes, 8 on each side of the head. Postantennal organ absent. Upper claw with distinct inner tooth about the middle, 1 small lateral

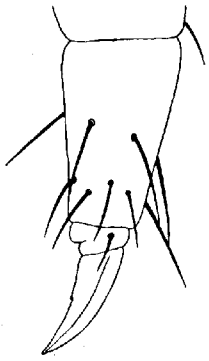

FIG. 3.—*Pseudachorutes asigillatus*, Börn. 1st, tibio-tarsus and claw, from the side.

tooth on each side near the base. Tibio-tarsus without clavate hairs. Anal horns absent. Colour blue-grey, underside lighter.

Hab.—Berkhamsted, under moist bark (fairly common); Kimpton, Welwyn, under piece of oak (few).

This species has not been previously recorded from this country.

Genus **Neanura**, MacG.

Neanura, MacGillivray.

17.—**Neanura muscorum** (Templ.).

Achorutes muscorum, Templeton, Thys. Hib., 1834, p. 97.
Achorutes tuberculatus, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 51.
Anoura muscorum, Lubbock, Monograph, 1873, p. 197.

Eyes, 3 on each side of the head, the 2 anterior near together, the posterior one some distance away. Postantennal organ absent. Mouth-parts suctorial, produced cone-like in front of the head. Upper claw without teeth. Lower claw absent. Clavate hairs absent. Abd. VI terminating in 2 tubercles. Segmental tubercles present. Colour, dark grey-blue or purple.

Hab.—Berkhamsted, under logs and sticks on the ground (very common); Ashridge, Berkhamsted, under sticks and amongst leaves (common); Kimpton, Welwyn, under sticks (few); Waterend, under a stick (3); Little Gaddesden, under moist bark (2).

Family ENTOMOBRYIDAE, D.T.

Entomobryidae, Dalla Torre.
Entomobryidæ, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 14.

Sub-family **Isotominae**, Schäff., Börn.

Isotominae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.
Isotomini, Börner, Vorläuf. Mitth. über ein. neue Aphor, 1901, p. 14.

Genus **Isotoma**, Bourl., Börn.

Isotoma, Bourlet, Mém. s. l. Podures, 1839. p. 23.*
Isotoma, Börner, Das Syst. d. Coll., 1906, p. 171.

18.—**Isotoma viridis**, Bourl., Schött.

Isotoma viridis, Bourlet, Mém. s. l. Podures, 1839.*
Isotoma anglicana, Lubbock, Monograph, 1873, p. 171.
Isotoma viridis, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 59.

Eyes, 8 on each side of the head. Upper claw with 2 inner teeth and 1 strong lateral tooth on each side. Lower claw about half as long as the upper with a small tooth on the inner side. Tibio-tarsus without clavate hairs. Mucro with 3 teeth, the 2 proximal ones opposite each other.

Hab.—Berkhamsted, under sticks, fence rail on ground, overturned sheep trough, etc. (very common); Kimpton, Welwyn, under a piece of wood (common); Waterend, under a log (common).

19.—**Isotoma grisea**, Lubb.

Isotoma grisea, Lubbock, Notes on the Thys., Pt. IV, 1870, p. 278.
Isotoma grisea, Lubbock, Monograph, 1873, p. 172.
Isotoma grisescens, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 188.

Eyes, 8 on each side of the head. Postantennal organ long and narrow. Ant. II longer than Ant. III. Upper claw with 1 inner tooth about the middle and 1 lateral tooth on each side near the base.

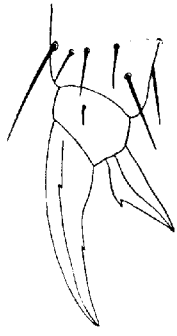

FIG. 4.—*Isotoma grisea*, Lubb. 3rd foot, from the side.

Lower claw half as long as the upper with 1 tooth on the inner side. Tibio-tarsus without clavate hairs. Mucro with four teeth, 3 in the middle line, and 1 on the outer side. The 2 distal teeth are much larger than the proximal teeth. Colour bluish grey.

Hab.—Berkhamsted, under sticks in a garden (common); amongst loose soil (few); under over-turned sheep trough (few); Waterend, under sticks (few).

Carpenter and Evans (20, p. 248) record this species from from several localities in Scotland under the name of *Isotoma grisescens*, thinking it probably identical with Lubbock's *I. grisea*. We are of the opinion that the two are synonymous.

20.—**Isotoma minor**, Schäff.

Isotoma minor, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 182.

Eyes absent. Postantennal organ absent. Near the end of Ant. IV. are 6-7 blunt sensory hairs. Upper claw without inner or lateral teeth. Lower claw broad at base, pointed, about half as long as

FIG. 5.—*Isotoma minor*, Schäff. Mucro, from the side.

the upper. Tibio-tarsus without clavate hairs. Body segments with some large feathery hairs. Colour very light grey or white. Length 1 mm.

Hab.—Berkhamsted, under sticks in a wood (few); under flower-pots in a greenhouse (few); under a stone (1).

21.—**Isotoma notabilis**, Schäff.

Isotoma notabilis, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 187.

Eyes, 4 on each side of the head. Postantennal organ very large, broad elliptical, nearly as large as the eye-patch. Upper claw without inner or lateral teeth. Lower claw without teeth, half as long as the upper. Tibio-tarsus without clavate hairs. Dentes very slender. Mucro with 3 teeth, 2 in the middle line, and 1 on the outer side. Colour, light grey.

Hab.—Berkhamsted, under flower-pots in greenhouses (common); under sticks (few); under bark of rotting oak (few); under an over-turned sheep-trough (fairly common); Kimpton, Welwyn, in greenhouse (few).

This species has not previously been recorded from the British Isles.

22.—**Isotoma arborea** (Linn.), Ågr.

Podura arborea, Linné, Syst. Nat., Ed. X., 1758.*
Isotoma arborea, Lubbock, Monograph, 1873, p. 167.
Isotoma denticulata, Schäffer, Coll. d. Umgeb. v. Hamb., 1896. p. 189.
Isotoma arborea, Ågren, Zur Kenn. d. Apt. Sud.-Schw., 1903, p. 140.

Eyes, 8 on each side of the head. Posterior eyes smaller than the others. Postantennal organ oval, $1\frac{1}{2}$ times as long as the diameter of 1 anterior eye. Upper claw with 1 inner tooth one-third from the distal end and 1 lateral tooth on each side one-third from the proximal end. Lower claw broad at the base with 1 small inner tooth. Front pair of legs with 2, middle and hind with 3 clavate hairs. Dens twice as long as the manubrium. Mucro with 4 teeth, 3 in the middle line and 1 at the outer side. Colour reddish violet to black, legs and furcula colourless.

Hab.—Berkhamsted, under bark of posts and rails (common); amongst decaying leaves (few); Kimpton, Welwyn, under log of wood (few).

Carpenter and Evans in 1899 (20, p. 223 and 250) claimed the first British record of this species, but Lubbock recorded it in 1873 from Great Britain (52, p. 168).

23.—**Isotoma cinerea** (Nic.).

Desoria cinerea, Nicolet, Rech. p.s. à l'hist. d. Pod., 1842, p. 60.

Eyes, 8 on each side of the head, all about the same size. Upper claw with 1 inner tooth and 1 small lateral tooth on each side. Tibio-

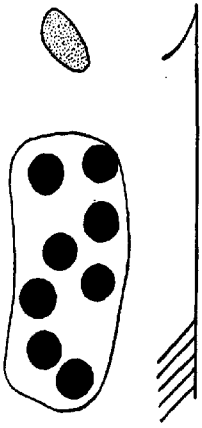

FIG. 6.

FIG. 7.

FIG. 6.—*Isotoma cinerea* (Nic.). Left eye-spot and postantennal organ.
FIG. 7.—*Isotoma cinerea* (Nic.). Mucro, from the side. (*After Collinge*).

tarsus with 2-3 clavate hairs. Mucro with 4 teeth, 3 in the middle line and 1 on the outer side. Colour grey, mottled with some violet pigment.

Hab.—Berkhamsted, under the bark of a dead Beech tree (few); under bark of rotting oak sticks (common); Kimpton, Welwyn, under sticks (few).

Genus **Proisotoma,** Börn.

Proisotoma, Börner, Das Syst. d. Coll., 1906, p. 172.

24.—**Proisotoma schötti** (D.T.).

Isotoma litoralis, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 75.
Isotoma schötti, Dalla Torre, Die Gatt. u. Art. d. Apt., 1895.*

Eyes, 8 on each side of the head. Upper claw without inner or lateral teeth. Lower claw broad at the base, tapering to a point.

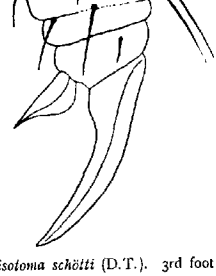

FIG. 8.—*Proisotoma schötti* (D.T.). 3rd foot from the side.

Tibio-tarsus without clavate hairs. Dentes not tapering. Mucro with 2 teeth. Colour violet.

Hab.—Berkhamsted, on water in a cart rut (3).

Schött's name *litoralis* being pre-occupied, Dalla Torre renamed the species in 1895.

Genus **Folsomia,** Willem.

Folsomia, Willem, Note prélim. s.l. Coll. d. grottes d. Han et d. Roch., 1902, p. 280.

25.—**Folsomia fimetaria** (L., Tullb.).

Podura fimetaria, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Isotoma alba, Tullberg, Förh. öfv. Sv. Pod., 1871, p. 152.
Isotoma fimetaria, Tullberg, Sver. Pod., 1872, p. 48.

Eyes absent. Postantennal organ elongate-oval. Upper claw without inner or lateral teeth. Tibio-tarus without clavate hairs. Dens about twice as long as the manubrium. Mucro with 2 teeth. Colour white.

Hab.—Berkhamsted, in a cellar under flower-pots (few); under bark of decaying log (common); in ant's nest (few); Waterend, under a log (3).

26.—**Folsomia quadrioculata** (Tullb.).

Isotoma quadrioculata, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 152.

Eyes, 2 on each side of the head. Postantennal organ elongate-oval. Upper claw without inner or lateral teeth. Tibio-tarsus without clavate hairs. Furcula shorter than in *fimetaria*. Dens equal to or a little longer than the manubrium. Mucro with 2 teeth. Colour grey, pigment mottled.

Hab.—Berkhamsted, under sticks lying on the ground (few); amongst decaying leaves (few); under flower-pots in a greenhouse (few); Ashridge, Berkhamsted, under sticks (few); Kimpton, Welwyn, under sticks (few); Waterend, under a log (2).

var. **diplophthalma** (Axels.).

Isotoma binoculata, Collinge and Shoebotham, Notes on some Coll. new to Gt. Britain, 1909, p. 88.

Eyes, 1 on each side of the head. Colour white with a little greyish pigment.

Hab.—Berkhamsted, under a flower-pot in a greenhouse (1).

Axelson (3) described the above variety as a separate species in 1902, but in his Apterygoten-fauna Finlands, 1907, he regards it as a variety of *quadrioculata*, Tullberg. We were mistaken in identifying our specimen (28) with the *Isotoma binoculata* of Wahlgren (73).

Genus **Anurophorus**, Nic., Tullb.

Anurophorus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 52.
Anurophorus, Tullberg, Skand Podur. af underfam. Lip., 1869, p. 12.

27.—**Anurophorus laricis**, Nic.

Anurophorus laricis, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 53.
Lipura corticina, Lubbock, Monograph, 1873, p. 191.

Eyes, 8 on each side of the head. Postantennal organ in a groove, ringlike as in *Isotoma*. Upper claw without inner or lateral teeth. Lower claw absent. Tibio-tarsus with 4 clavate hairs.

Furcula and tenaculum totally absent. Anal horns absent. Colour dark blue to black.

Hab.—Berkhamsted, on puddle of water in a road (few); under bark of dead tree (few); under bark of fence post (few); under board in a garden (fairly common).

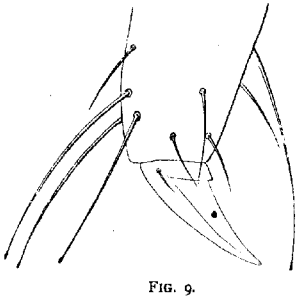

FIG. 9.

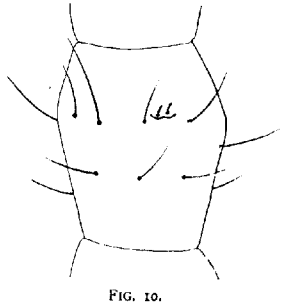

FIG. 10.

FIG. 9.—*Anurophorus laricis* (Nic.). 3rd foot from the side.
FIG. 10.—*Anurophorus laricis* (Nic.). 3rd antennal joint from the side, showing the antennal-organ III. (*After Collinge.*)

Sub-family **Tomocerinae**, Schäff.

Tomocerinae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.

Genus **Tomocerus**, Nic.

Tomocerus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 67.

28.—**Tomocerus vulgaris** (Tullb.).

Macrotoma vulgaris, Tullberg, Förh. öfv. Sv. Pod., 1871, p. 149.

Antennae shorter than the body. Upper claw with 5-6 inner teeth and 1 large lateral tooth (pseudonychium) on each side. Lower claw lanceolate, without teeth. Spines on the dentes, simple.

Hab.—Berkhamsted, under fence rail on the ground (common); under boards and logs of wood (few); in a cellar on fire-wood (2); in greenhouses (fairly common); Kimpton, Welwyn, under a piece of wood (few).

29.—**Tomocerus minor** (Lubb.).

Macrotoma minor, Lubbock, Notes on the Thys., pt. II, 1862, p. 598.
Macrotoma tridentifera, Tullberg. Sver. Pod., 1872, p. 37.
Tomocerus plumbeus, Lubbock, Monograph, 1873, p. 138.

Antennae shorter than the body. Upper claw with 5-6 inner teeth and 1 large lateral tooth (pseudonychium) on each side. Lower claw with 1 tooth on the inner side. Spines on the dentes, tridentate.

Hab.—Berkhamsted, under logs, stones, boards, and decaying leaves (very common); Kimpton, Welwyn, under oak log (fairly common); Waterend, under logs (common).

30.—**Tomocerus longicornis** (Müll.).

Podura longicornis, Müller, Zool. Dan. Prod., 1776.*
Tomocerus plumbeus, Nicolet, Rech. p. serv. à l'hist. d. Pod., 1842, p. 68.
Macrotoma plumbea, Lubbock, Notes on the Thys., Pt. II, 1862, p. 598.
Macrotoma plumbea, Tullberg, Sver. Pod., 1872, p. 37.
Tomocerus longicornis, Lubbock, Monograph, 1873, p. 137.

Antennae longer than the body. Upper claw with 2-3 inner teeth. Lower claw with apical appendage reaching almost to the end of the upper. Spines on the dentes, simple.

Hab.—Berkhamsted, under sticks and decaying leaves (fairly common).

Sub-family **Entomobryinae**, Schäff., Börn.

Entomobryinae, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 177.
Entomobryini, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 15.

Genus **Isotomurus**, Börn.

Isotomurus, Börner, Neue Altwelt. Coll., 1903.*

31.—**Isotomurus palustris** (Müll.).

Podura palustris, Müller, Zool. Dan. Prod., 1776.*
Podura aquatilis, Müller, Zool. Dan. Prod., 1776.*
Isotoma palustris, Lubbock, Monograph, 1873, p. 169.
Isotoma aquatilis, Lubbock, Monograph, 1873, p. 170.

Hab.—Berkhamsted, on the water of grassy ponds (very common); under decaying pieces of wood (common); Waterend, on water of mill-pool (common).

var. **fucicola** (Reut.).

Hab. Berkhamsted, on the water of grassy ponds (common).

var. **prasina** (Reut.).

Hab.—Berkhamsted, under decaying pieces of wood lying in a grass field (common).

32.—**Isotomurus maculatus** (Schäff., Börn.).

Isotoma palustris var. *maculata*, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 186.
Isotoma maculata, Börner, Apterygoten-Fauna von Bremen, 1901, p. 51.

Hab.—Berkhamsted, about flower-pots in greenhouses (very common); on a brick in a garden (fairly common).

Genus **Entomobrya**, Rond.

Entomobrya, Rondani, Dipterol. Ital. Prodr., Vol. IV.*
Degeeria, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 70.
Entomobrya, Brook, A Revis. of the Gen. Entom., 1883, p. 272.

33.—**Entomobrya nivalis** (Linn.).

Podura nivalis, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Degeeria annulata, Lubbock, Monograph, 1873, p. 159.

Hab.—Kimpton, Welwyn, in greenhouse (few); Berkhamsted, amongst moss in a hedge (few); under bark of fence posts (common); on Gorse bush (few); on hawthorn bush (very common).

34.—**Entomobrya albocincta** (Templ.).

Podura albocincta, Templeton, Thys. Hib., 1834, p. 95.
Degeeria cincta, Lubbock, Monograph, 1873, p. 162.
Degeeria albocincta, Lubbock, Monograph, 1873, p. 160.

Hab.—Berkhamsted, under bark of posts and rails, etc. (very common); under wood lying on the ground (few); in a greenhouse (few); Kimpton, Welwyn, under sticks (few).

35.—**Entomobrya nicoleti** (Lubb.).

Degeeria nicoletii, Lubbock, Notes on the Thys., Pt. III, 1868.
Degeeria nicoletii, Lubbock, Monograph, 1873, p. 161.

Hab.—Berkhamsted, under pieces of wood (common); under bark of rails and posts (common); Waterend, under bark of fence-post (5).

36.—**Entomobrya multifasciata** (Tullb.).

Degeeria multifasciata, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 148.
Degeeria nivalis, Lubbock, Monograph, 1873, p. 158.

Hab.—Berkhamsted, under logs of wood and sticks lying on the ground (common); beaten from grass (few).

Genus **Sinella**, Brook.

Sinella, Brook, On a new Gen. of Coll. allied to *Degeeria*, 1882, p. 543.

37.—**Sinella curviseta,** Brook.

Sinella curviseta, Brook, On a new Gen. of Coll. allied to *Degeeria*, 1882, p. 544.

Eyes, 2 on each side of the head. Upper claw with 3 inner teeth, the 2 proximal opposite each other. Lower claw without teeth. Mucro with 2 teeth and basal spine. Colour yellow with mottling of reddish pigment.

Hab.—Berkhamsted, in flower-pots in greenhouse (few).

38.—**Sinella höfti,** Schäff.

Sinella höfti, Schäffer, Coll. d. Umgeb. v. Hamb., 1896, p. 192.

Eyes absent. Upper claw with 3 inner teeth, 2 large proximal ones opposite each other and 1 smaller distal tooth about the middle. Lower claw with toothed outer lamella as in *Cyphoderus albinus*.

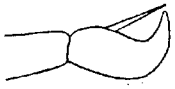

FIG. 11.—*Sinella höfti*, Schäff. Mucro, from the side.

Tibio-tarsal spur-hair pointed. Mucro with 1 tooth and basal spine. Colour white.

Hab.—Berkhamsted, in flower-pots in a greenhouse (common); under stones (few).

Genus **Seira,** Lubb.

Seira, Lubbock, Notes on the Thys., pt. IV, 1870, p. 279.
Seira, Lubbock, Monograph, 1873, p. 143.

39.—**Seira nigromaculata**, Lubb.

Seira nigromaculata, Lubbock, Monograph, 1873, p. 146.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes ventrally without scales. Mucro with 2 teeth and basal spine. Colour in life, greyish, in spirit, yellow with some darker markings.

Hab.—Berkhamsted, on window-sills, walls, gate posts, etc., about a cattle yard (common).

40.—**Seira buskii,** Lubb.

Seira buskii, Lubbock, Notes on the Thys., Pt. IV, 1870, p. 280.
Seira buskii, Lubbock, Monograph, 1873, p. 145.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes ventrally without scales. Mucro with 2 teeth and basal spine. Colour of body, dark violet; head, legs, and base of the antennae yellow.

Hab.—Berkhamsted, about flower-pots in a greenhouse (few).

Genus **Pseudosira**, Schött, Börn.

Pseudosira, Schött.
Pseudosira, Börner, Das Syst. d. Coll., 1906, p. 174.

41.—**Pseudosira domestica** (Nic.).

Degeeria domestica, Nicolet, Rech. p. s. à l'hist. d. Pod , 1842, p. 76.
Seira domestica, Lubbock, Monograph, 1873, p. 144.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth and 1 lateral tooth on each side. Lower claw lanceolate. Tibio-

FIG. 12.—*Pseudosira domestica* (Nic.). End of dens and mucro, from the side.

tarsus with 1 clavate hair. Dentes ventrally with scales. Mucro with 1 tooth, without basal spine. Colour brown.

Hab.—Berkhamsted, on and under flower-pots in a greenhouse (few).

Genus **Lepidocyrtus**, Bourl.

Lepidocyrtus, Bourlet, Mém. s. l. Podures, 1839.*
Lepidocyrtus, Börner, Das Syst. d. Coll., 1906, p. 174.

42.—**Lepidocyrtus curvicollis**, Bourl.

Lepidocyrtus curvicollis, Bourlet, Mém. s. l. Podures, 1839.*
Lepidocyrtus curvicollis, Lubbock, Monograph, 1873, p. 150.

Eyes, 8 on each side of the head. Head almost concealed under the projecting mesothorax. Upper claw with 2 inner teeth and 1 large lateral tooth on each side. Lower claw lanceolate, reaching to the second tooth on the upper claw. Tibio-tarsus with 1 clavate hair.

Hab.—Berkhamsted, on firewood in a cellar (common); on flower-pots in greenhouses (common); Kimpton, Welwyn, in greenhouse (fairly common).

This is the largest of the British species of *Lepidocyrtus*.

43.—**Lepidocyrtus lanuginosus** (Gmel.), Tullb.

Podura lanuginosa, Gmelin, Linn. Syst. Nat., T.I., 1788, p. 2911.
Lepidocyrtus lanuginosus, Tullberg, Sver. Pod., 1872, p. 38.

Eyes, 8 on each side of the head. Mesothorax projecting over the head more than in *cyaneus*. Upper claw with 2 inner teeth and 1 large lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes slightly longer than the manubrium. Colour, silvery blue, in spirit pale yellow.

Hab.—Berkhamsted, under sticks and stones (common); amongst decaying leaves (fairly common).

44.—**Lepidocyrtus ruber,** Schött.

Lepidocyrtus lanuginosus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 74.
Lepidocyrtus ruber, Schött, Étud. s.l. Coll. d. Nord, 1902, p. 31.

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth about the middle, and 1 small lateral tooth on each side. Lower claw

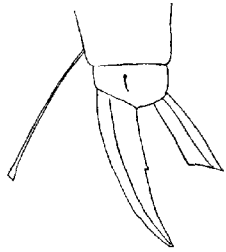

FIG. 13.—*Lepidocyrtus ruber*, Schött. 3rd foot, from the side.

with almost parallel sides for three-quarters of its length, then the inner lamella is suddenly cut away. Tibio-tarsus with 1 clavate hair.

Hab.—Berkhamsted, on aquatic plants and on water in a pond (few).

This is the first record of this species for this country.

45.—**Lepidocyrtus cyaneus,** Tullb.

Lepidocyrtus cyaneus, Tullberg, Förh. öfv. Sv. Pod., 1871, p. 150.
Lepidocyrtus purpureus, Lubbock, Monograph, 1873, p. 155.

Eyes, 8 on each side of the head. Mesothorax projecting very little over the head. Upper claw with 2 inner teeth and 1 small lateral tooth on each side. Lower claw lanceolate. Tibio-tarsus with 1 clavate hair. Dentes a little shorter than the manubrium.

Colour of body, dark blue, in spirit dark blue. Head, base of antennae and legs, yellow.

Hab.—Berkhamsted, under sticks and boards (few); amongst newly-mown grass (fairly common); under stones in an arable field (few).

46.—**Lepidocyrtus sexoculatus** (Schött).

Pseudosinella sexoculata, Schött, Étud. s. l. Coll. d. Nord, 1902, p. 34.
Lepidocyrtus sexoculatus, Guthrie, Coll. of Minn., 1903, p. 86.

Eyes, 3 on each side of the head, placed on 2 distinct eye-spots, the anterior one having 2 and the posterior one 1.

Hab.—Berkhamsted, under stick lying on the ground (1); in greenhouse (1).

47.—**Lepidocyrtus albus,** Pack.

Lepidocyrtus albus, Packard, Syn. Thys. Essex Co. Mass., 1873.*
Tullbergia ocellata, Lie-Pettersen, Norges Coll., 1896, p. 16.
Pettersenia ocellata, Lie-Pettersen, Apt. Sogn. u. Nordfj., 1898, p. 10.
Pseudosinella alba, Schäffer, Würrt. Coll., 1900, p. 269.

Eyes, 2 on each side of the head, on a black patch. Upper claw with 3 inner teeth, the 2 proximal large and opposite, the distal one

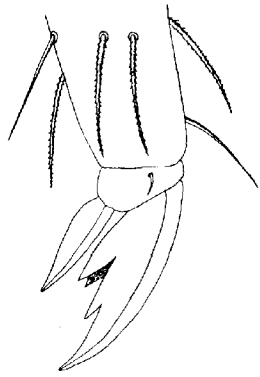

FIG. 14.—*L.epidocyrtus albus*, Pack. 1st foot, from the side.

smaller. Lower claw lanceolate. Tibio-tarsal spur-hair pointed. Colour silvery white.

Hab.—Berkhamsted, under sticks and boards lying on the ground (fairly common); amongst decaying leaves (few); in loose soil (common).

48.—**Lepidocyrtus cavernarum** (Mon.).

Seira cavernarum, Moniez, Esp. nouv. d. Thys. trouv. dans. l. Grotte de Darg, 1893.*
Cyphoderus martelli, Carpenter, Coll. of Mitch. Cave, 1897, p. 228.
Tullbergia immaculata, Lie-Pettersen, Norges Coll., 1896, p. 16.
Cyphoderus albinos, Guthrie, Coll. of Minn., 1903.

Eyes absent. Upper claw with 3 inner teeth, the 2 proximal lamella-like, opposite each other. The distal tooth is small. Tibio-tarsal spur-hair pointed. Colour white.

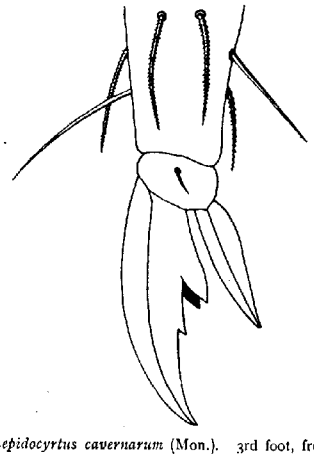

FIG. 15.—*Lepidocyrtus cavernarum* (Mon.). 3rd foot, from the side.

Hab.—Berkhamsted, under stones and sticks lying in loose soil (few).

Genus **Orchesella**, Templ.

Orchesella, Templeton, Thys. Hib., 1834, p. 92*

49.—**Orchesella cincta** (Linn.), Lubb.

Podura cincta, Linné, Syst. Nat., Ed. X, 1758, p. 609.*
Orchesella cincta, Lubbock, Monograph, 1873, p. 129.

Eyes, 8 on each side of the head. Upper claw with 3 inner teeth. Tooth on the outer side of the lower claw, in the distal half. Abd. III with a distinct black band.

Hab.—Berkhamsted, under bark of posts and rails (few); under boards (common); amongst decaying leaves (common); under sticks and logs of wood (very common); Kimpton, Welwyn, in green-house (few); under sticks (common).

var. **vaga** (Linn.).

Hab.—Berkhamsted, under a fence rail lying on the ground (common).

50.—**Orchesella villosa** (Geoff.), Lubb.

Podura villosa, Geoffroy, Hist. abr. d. Insect. qui s. trouv. aux Env. d. Paris, 1762.*
Orchesella villosa, Lubbock, Monograph, 1873, p. 131.

Eyes, 8 on each side of the head. Upper claw with 2 inner teeth. Tooth on the outer side of the lower claw, in the proximal half. Body without any distinct transverse bands.

Hab.—Berkhamsted, on decaying potato (3); under a board in a garden (common); under sticks, bark, stones, etc., lying on the ground (common); amongst decaying leaves (common).

Genus **Heteromurus**, Wankel.

Heteromurus, Wankel, Beit. z. mähr. Grotteaf, 1861.*
Templetonia, Lubbock, Notes on the Thys., Pt. II., 1862, p. 595.

51.—**Heteromurus nitidus** (Templ.).

Podura nitida, Templeton, Thys. Hib., 1834, p. 94.
Templetonia crystallina, Lubbock, Monograph, 1873, p. 143.

Terminal segment of the antenna ringed. Eyes, 1 on each side of the head. Upper claw with 2 inner teeth placed opposite each other near the base, and 1 lateral tooth on each side near the base. Lower claw with a small tooth on the outer side. Mucro with 2 teeth, without basal spine. Scales present. Colour silvery white, with a little reddish pigment.

Hab.—Berkhamsted, common under flower-pots in greenhouses; under stones in loose soil; and under sticks and boards.

Genus **Cyphoderus**, Nic, Tullb.

Cyphoderus, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 63.
Cyphoderus, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 150.

52.—**Cyphoderus albinus**, Nic.

Cyphoderus albinus, Nicolet, Rech. p. s. à l'hist. d. Pod., 1842, p. 67.
Beckia albinos, Lubbock, Monograph, 1873, p. 149.

Ant. II longer than Ant. III. Eyes absent. Upper claw with 1 large inner tooth. Lower claw with broad, toothed outer lamella. Tibio-tarsus with 1 clavate hair. Dens twice as long as the mucro. Mucro elongate, with 2 distal teeth. Colour white.

Hab.—Berkhamsted, in ant's nests in the ground (few); in an ant's nest in a flower-pot (3); Frithesden, near Berkhamsted, in ant's nests (few).

Sub-order **Symphypleona,** Börn.

Symphypleona, Börner, Vorläuf. Mitth. über ein. neue Aphor., 1901, p. 5.
Symphypleona, Börner, Apterygoten-Fauna von Bremen, 1901, p. 78.

Family NEELIDAE, Fols.

Neelidae, Folsom, *Neelus m.* repr. a new Thys. Fam., 1896, p. 391.
Neelidae, Börner, Coll. Symph., Fam. Neel., 1906, p. 2.

Genus **Neelus,** Fols.

Neelus, Folsom, *Neelus m.* repre. a new Thys. Fam., 1896, p. 391.
Neelus, Börner, Coll. Symph., Fam. Neel., 1906, p. 3.

53.—**Neelus murinus,** Fols.

Neelus murinus, Folsom, *Neelus m.* repr. a new Thys. Fam., 1896, p. 391.

Hab.—Berkhamsted, under flower-pots in a greenhouse and under sticks in a wood (few).

Genus **Megalothorax,** Willem.

Megalothorax, Willem, Un type nouv. de sminth. *Megaloth.*, 1900, p. 7-10.
Megalothorax, Börner, Coll. Symph. Fam. Neel., 1906, p. 3.

54.—**Megalothorax minimus,** Willem.

Megalothorax minimus, Willem, Un type nouv. de sminth. *Megaloth.*, 1900, p. 7-10.
Megalothorax minimus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 82.
Amerus normani, Collinge & Shoebotham, Desc. of a New Gen. of Coll. of the Fam. Neel., 1909, p. 47.

Hab.—Berkhamsted, under flower-pots in a greenhouse and under decaying wood embedded in loose soil (few); Little Gaddesden, under moist bark (1).

Family SMINTHURIDAE, Lubb.

Smynthuridae, Lubbock, Notes on the Thys., pt. I, p. 430.
Sminthuridae, Börner, Apterygoten-Fauna von Bremen, 1901, p. 85.

Sub-family **Sminthuridinae,** Börn.

Sminthuridinae, Börner, Das Syst. d. Coll., 1906, p. 163.

Genus **Sminthurides,** Börn.

Sminthurides, Börner, Apterygoten-Fauna von Bremen, 1901, p. 91.

55.—**Sminthurides aquaticus** (Bourl.).

Smynthurus aquaticus, Bourlet, Mém. s.l. Podurelles, 1843.

Eyes, 8 on each side of the head. Upper claw of first and second pairs of legs with 1 inner tooth, third pair without. Sub-

apical bristle of the under claw of the first pair of legs not quite reaching to the end of the upper claw. Dens three times as long as the mucro. Mucro with broad lamella. Colour green.

Hab.—Berkhamsted, on herbage around, and on the surface of water of ponds (common).

56.—**Sminthurides malmgreni** (Tullb.), var. **elegantula** (Reut.).

Sminthurus malmgrenii, Tullberg, Coll. Bor., 1876, p. 30.
Sminthurus elegantulus, Reuter, Étud. s. l. Coll., 1880, p. 20.*
Sminthurus malmgrenii, var. *elegantulus*, Schött, Zur Syst. u. Verb. Pal. Coll., 1893, p. 35.

Eyes, 8 on each side of the head. Upper claw of first and second pairs of legs with 1 inner tooth, third pair without. Subapical bristle of the under claw of the first pair of legs reaching past the end of the upper claw. Dens two-and-half to three times as long as the mucro. Mucro with broad lamella. Colour, yellow with three broad longitudinal brown bands.

Hab.—Berkhamsted, about grassy ponds, on the herbage and on the surface of the water (fairly common).

57.—**Sminthurides violaceus** (Reut.).

Sminthurus violaceus, Reuter, För Finl. nya Coll., 1878, p. 203.*

Eyes, 8 on each side of the head. Upper claw with 1 inner tooth. Dens about twice as long as the mucro. Mucro, elongate, without broad lamella. Colour violet.

Hab.—Berkhamsted, few on water lying in cart ruts, and on garden footpath.

Genus **Sminthurinus**, Börn.

Sminthurinus, Börner, Apterygoten-Fauna von Bremen, 1901, p. 99.

58.—**Sminthurinus niger** (Lubb.).

Smynthurus niger, Lubbock, Notes on the Thys., Pt. III, 1868.*
Smynthurus niger, Lubbock, Monograph, 1873, p. 111.

Hab.—Berkhamsted, under and about flower-pots in greenhouses (fairly common); under a flower-pot in a garden (few).

59.—**Sminthurinus fenestratus**, Börn.

Sminthurinus fenestratus, Börner, Jap. Coll., 1909, p. 124.
Sminthurus biflavopunctatus, Collinge & Shoebotham, Descr. of two new sp. of Coll., 1909, p. 9.

Hab.—Berkhamsted, under and about flower-pots in greenhouses (common).

In April, 1909, we described the above species from specimens taken in Berkhamsted, but Dr. Börner afterwards pointed out that it was synonymous with his *Sminthurinus fenestratus,* from Japan, the description of which was published two months previously.

60.—**Sminthurinus aureus** (Lubb.).

Smynthurus aureus, Lubbock, Notes on the Thys., Pt. II, 1862, p. 589.
Smynthurus aureus, Lubbock, Monograph, 1873, p. 112.

Eyes, 8 on each side of the head. Upper claw without inner teeth. Tibio-tarsus with 4-5 clavate hairs. Mucro with fine dorsal teeth. Colour, golden yellow.

Hab.—Berkhamsted, under sticks and decaying leaves on the ground (common).

var. **ochropus** (Reut.).

Hab.—Berkhamsted, under sticks on the ground in a grass field (few).

Genus **Arrhopalites,** Börn.

Arrhopalites, Börner, Das Syst. d. Coll., 1906, p. 182.

61.—**Arrhopalites caecus** (Tullb.).

Sminthurus caecus, Tullberg, Fört. öfv. Sv. Pod., 1871, p. 146.

Eyes absent. Upper claw with 1 inner tooth about the middle. Tibio-tarsus without clavate hairs. Mucro ending in a knob. Colour white, with a little reddish pigment.

Hab.—Kimpton, Welwyn, in a greenhouse (few); Berkhamsted, under flower-pots in a greenhouse (few).

Sub-family **Sminthurinae,** Börn.

Sminthurinae, Börner, Das Syst. d. Coll., 1906, p. 163.

Genus **Bourletiella,** Banks, Börn.

Bourletiella, Banks.
Bourletiella, Börner, Das Syst. d. Coll., 1906, p. 182.

62.—**Bourletiella hortensis** (Fitch).

Smynthurus hortensis, Fitch, 8th Report on the Nox. and other Ins. of the State of New York, 1862, p. 186.*

May be distinguished from *B. lutea* (Lubb.), by the inner tooth of the upper claw of the third foot being nearer the distal end. The

sub-segments in Ant. IV of *lutea* are more distinct than in *hortensis*.

Hab.—Berkhamsted, on water in a cart rut (fairly common); on garden footpath (few).

63.—**Bourletiella lutea** (Lubb.).

Smynthurus luteus, Lubbock, Notes on the Thys., Pt. III, 1868, p. 296.*
Smynthurus luteus, Lubbock, Monograph, 1873, p. 108.

Eyes, 8 on each side of the head. All three pairs of feet alike. Upper claw with 1 inner tooth about the middle, and 1 lateral tooth on each side a little nearer the proximal end. Lower claw rather more than half as long as the upper, with narrow outer and broader inner lamella, with a short sub-apical bristle not reaching to the end of the upper claw. Tibio-tarsus with 2-3 clavate hairs. Colour yellow.

Hab.—Berkhamsted, amongst newly-mown grass (few); on a puddle of water (few).

64.—**Bourletiella bilineata** (Bourl.).

Smynthurus bilineatus, Bourlet, Mém. s. l. Pod., 1843, p. 58.*

Lower claw of first pair of legs with apical bristle reaching past the end of the upper claw; of second, and third pairs of legs, with broad inner and narrow outer lamella, shorter than the upper claw.

Hab.—Berkhamsted, amongst grass (few).

65.—**Bourletiella sulphurea** (Koch), Börn.

Sminthurus sulphureus, Koch, Poduridae, 1840.*
Bourletiella sulphurea, Börner, Coll. aus Südafrika, 1908, p. 54.

Lower claw, on all feet with only indistinct lamella, about half as long as the upper claw.

Hab.—Berkhamsted, on Red Currant leaves (few).

var. **pallipes** (Bourl.).

Hab.—Berkhamsted, on Red Currant leaves along with the yellow form.

Genus **Sminthurus**, Latr., Börn.

Smynthurus, Latreille, Hist. Nat. Crust. et Ins., 1804.*
Sminthurus, Börner, Das Syst. d. Coll., 1906, p. 183.

66.—**Sminthurus viridis** (Linn.).

Podura viridis, Linné, Syst. Nat., Ed. X, 1758, p. 608.*
Smynthurus viridis, Lubbock, Monograph, 1873, p. 100.

Hab.—Berkhamsted, on puddles of water in a pasture field (few); under rails on the ground (few); amongst newly-mown grass (fairly common); amongst heather (few).

Genus **Allacma**, Börn.

Allacma, Börner, Das Syst. d. Coll., 1906, p. 183.

67.—**Allacma fusca** (Linn.).

Podura fusca, Linné, Syst. Nat., Ed. X, 1758, p. 608.*
Smynthurus fuscus, Lubbock, Monograph, 1873, p. 101.

Eyes, 8 on each side of the head. Upper claw with tunica and pseudonychium. Tibio-tarsus without clavate hairs. Dens with 2-3 clavate hairs. Mucro with toothed inner margin. Colour dark brown.

Hab.—Berkhamsted, under chips of wood and sticks (common).

Sub-Family **Dicyrtominae**, Börn.

Dicyrtominae, Börner, Neue Coll. u. z. Nomen. d. Coll. Lubb., 1901, p. 711.

Genus **Dicyrtoma**, Bourl., Börn.

Dicyrtoma, Bourlet, Mém. s. l. Podurelles, 1843.*
Dicyrtoma, Börner, Das Syst. d. Coll., 1906, p. 184.

68.—**Dicyrtoma fusca** (Luc., Lubb.).

Smynthurus fuscus, Lucas, Thys. d. l'Alg., 1849.*
Papirius cursor, Lubbock, Notes on the Thys., Pt. I, 1862, p. 436.
Papirius fuscus, Lubbock, Monograph, 1873, p. 120.

Upper claw without tunic, with 2 inner teeth and 2 lateral teeth on each side. Lower claw with long sub-apical appendage reaching past the end of the upper claw. Dens with setae serratae. Colour dark brown, head with a yellowish tinge.

Hab.—Berkhamsted, under a stick (1 specimen).

Genus **Dicyrtomina**, Börn.

Dicyrtomina, Börner, Das Syst. d. Coll., 1906, p. 183.

69.—**Dicyrtomina minuta** (O. Fabr., Tullb.).

Podura minuta, O. Fabricius, Besk. ov. nog. lid. bekj. Pod., og en besond. Loppe, 1783, p. 307.*
Papirius minutus, Tullberg, Sver. Pod., 1872, p. 35.
Papirius nigromaculatus, Lubbock, Monograph, 1873, p. 127.

Eyes, 8 on each side of the head. Upper claw with tunic. Dentes without setae serratae. Colour yellow, with squarish black anal patch.

Hab.—Berkhamsted, under sticks on the ground in a grass field (common); on water in a cart rut (fairly common); beaten from a Gorse bush (few).

var. **ornata** (Lubb.).

Hab.—Berkhamsted, under sticks, bark and rails on the ground (common); amongst decaying leaves (common).

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REVIEWS.

Daniels, C. W., and E. Wilkinson.—Tropical Medicine and Hygiene. Pt. i. Diseases due to Protozoa. Pp. v + 264, 2 cold. plts. and 69 figs. London: John Bale, Sons, Danielsson, Ltd. 1909. Price: 7s. 6d. net.

This work is to be completed in three parts. The first, under review, treats of those diseases known to be due to Protozoa; in the second part those diseases due to the higher forms of animal life will be considered; whilst part three will be devoted to bacterial diseases, to the effects of certain animal and vegetable poisons and to certain diseases, the causation of which is unknown or but imperfectly understood.

The authors open with a capital introductory chapter treating of the classification and life-history of the Protozoa; the various diseases are next very clearly described, then clinical features, methods of examination, and the preventive measures.

There are a series of very useful appendices, dealing with notable dates, important measurements, classification of Diptera, ticks, etc.

The work forms a most valuable addition to the literature on tropical medicine, and students of the same will look forward to the early completion of the remaining parts of what promises to be a standard treatise.

W. E. C.

Ellis, David.—Outlines of Bacteriology (Technical and Agricultural). Pp. xii + 262, 134 figs. London: Longmans, Green and Co., 1909. Price 7s. 6d. net.

Bacteriology plays so important a part in up-to-date agriculture that we are somewhat surprised that no one has ere now thought it worth while to incorporate within a readable volume the recent developments that are of fundamental importance.

Dr. Ellis' work is just the one that we have hitherto looked for (in vain), and we heartily commend it to all who take an interest in the subject.

The author has steered clear of controversial questions and those requiring a technical knowledge of a special nature, his aim being the demonstration of the fundamental principles which underlie that application, rather than the discussion of the details.

His own experience as a teacher of the subject has served him well, and we heartily commend this work as one of more than usual merit.

W. E. C.

Green, E. Ernest.—The Coccidae of Ceylon. Part iv, pp. 251-344, plts. xciv-cxxxii. London: Dulau and Co., 1909.

When about to issue the first part of this valuable monograph the author estimated that it would probably extend to four parts, each containing thirty plates. On completing the fourth part, however, he finds, in spite of the addition of the 15 extra plates, it will be necessary to bring out a fifth part of double size, containing from fifty to sixty plates.

The part before us deals with the remaining species of the sub-family *Lecaniinae*, treating of nine genera and nineteen species, of which ten are new, and commences the new sub-family *Asterolecaniinae*, treating of six genera, twenty-four species and two varieties, of which seventeen are new.

The work evidences an enormous amount of personal observation and investigation, whilst the labour bestowed upon the illustrations makes it one of the most important that has been issued upon this particularly interesting family of insects, and at the same time places students of the *Coccidae* and entomologists generally under a further debt of gratitude to the author.

We look forward with much interest to a further part and supplemental parts.

W. E. C.

Henderson, R.—The Estate Manager. Pp. xv + 548, 133 figs. Edinburgh: William Green and Sons, 1910. Price 15s.

The author has succeeded in presenting within the compass of a single volume a very complete résumé of the technical knowledge required by estate managers, and at the same time a useful work of reference. In the main he deals with the general principles, as a lead to beginners on one hand, and as matter that may be suggestine to many men in practice on the other.

The work contains much sound advice, and whilst in some cases we differ from the opinions expressed, it will be found most useful, and in many cases be distinctively suggestine of better methods.

Beginners will find much to absorb and profit by, and to such we recommend a careful perusal.

L. G.

Hewitt, C. Gordon.—The House Fly, *Musca domestica*, Linnaeus. Pp. xiii + 195, 10 plts. Manchester: The University Press. 1910. Price 20s. net.

We welcome the publication of Dr. Hewitt's papers on the House Fly in a single volume. The author has taken the opportunity of adding an

introduction, various appendices, and an index, all of which greatly add to the value of an excellent piece of work.

It seems strange that no one had previously thought it worth while to treat of this common insect in detail; it is another instance of the enormous amount of work that awaits the economic zoologist.

Dr. Hewitt's work is already known to zoologists throughout the world; it is therefore unnecessary to comment upon it beyond stating that it is thorough without being verbose, ably conceived, and beautifully illustrated.

We understand that only 200 copies are being offered for sale; those therefore desiring one should order at once.

W. E. C.

Massee, George.—Diseases of Cultivated Plants and Trees. Pp. xii + 632, 171 figs. London: Duckworth and Co., 1910. Price 7s. 6d. net.

It would be useless to deny the fact that from various sources there is a demand for a work on diseases of plants due to fungi. Hitherto we have had to content ourselves with the works by Hartig and Somerville, Dr. M. C. Cooke, Tubeuf and Smith, etc., but none of these exactly meet our requirements. True it is, there are one or two excellent but somewhat costly German works, but a work in English has been much desired; we are therefore somewhat surprised that the author of this excellent handbook has not attempted a much more ambitious production.

Mr. Massee's work deals with a number of causes of disease besides fungi, and his pertinent remarks on primary and secondary causes, epidemics, how plants are infected by fungus spores, how fungus diseases are disseminated, facts not generally known, wounds, drought, injuries due to frost and hail, chlorosis, injury by smoke, acid fumes, gas, etc., intumescens or warts, fasciation, bacteriology of the soil, economic aspects of plant diseases, fungicides, spraying, and injury caused by non-parasitic or undetermined organisms, though brief, will be read with interest.

In addition to the parasitic fungi-causing diseases, there are sections devoted to lichenes, bacteria, myxogastres, injuries caused by animals and birds, mites and eelworms.

Mr. Massee deprecates, as all right-thinking economic biologists must, the stump-orator "whose energies are expended in denouncing the powers that be for not promptly suppressing all traces of (the) disease from the British Empire." Such self-advertising methods we have no patience with, and they appear dreadfully purile and foolish by the side of the retiring and patient labours of the author of this manual.

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In the words of Colonel Prain, who contributes a short intoduction, the work is " the outcome of long-continued, personal investigation of the morphological and biological peculiarities of many types of the organisms that cause or are associated with cases of disease in plants, by a writer who is not only capable of representing accurately the views of others, but is competent to give reasons for the faith which he himself professes."

The book is well printed, in a handy form, and illustrated by numerous figures.

We have by no means exhausted the good features of this book, but the exigencies of space forbid us to go further.

There are a few omissions at which we are, in a sense, surprised; thus we find no mention of Professor Gilchrist's work on " Finger and Toe " disease, Professor Buller's on *Polyporus squamosus,* Miss Bayliss' on *Polystictus versicolor,* Mr. C. E. C. Fischer's on *Pestalozzia hartgii,* and Sir Charles Whitehead's on Potato Disease, all original contributions to the subject; whilst there is a large mass of literature which the author does not seem to have made use of, time and space, no doubt, being the causes.

We sincerely hope that the reception of the present volume will induce the author to undertake a much more ambitious work dealing with the various diseases in greater detail and with more illustrations.

W. E. C.

Theobald, Fred. V.—A Monograph of the *Culicidae* or Mosquitoes. Mainly compiled from Collections received at the British Museum. Vol. v, pp. xv + 646, plts. i-vi, 261 figs. London, 1910. Published by the Trustees of the British Museum. Price £1 5s. od.

The economic importance of the *Culicidae* have been responsible for a voluminous literature during the past few years, and the new genera and species seem legion.

In a preface to Mr. Theobald's fifth volume Dr. Harmer points out that the first two volumes have for some time been out of print, and it has been decided to include in the present volume some mention at least of all the species described in any of its predecessors.

The fifth volume contains descriptions of 21 genera and 392 species. We are glad to see that the author enters a protest against the wholly inadequate diagnoses of certain American writers, and against genera and species founded in larval characters. It is becoming more and more common amongst the entomologists of the United States to describe new genera and species in this manner, whilst in many cases illustrations are regarded as entirely superfluous.

Mr. Theobald has worked out synoptic tables of the genera and

species in each genus of the *Anophelinae, Megarhininae, Culicinae, Heptaphlebomyinae, Uranotaeninae,* but lack of time has not yet permitted him to do the same for all the *Aedinae,* not the unbanded-legged species of the genus *Culex*. These will undoubtedly prove most useful.

The author adheres to the system of classification by scale-structure, and to our surprise, it apparently works out well in practice. Taxonomic conclusions, founded upon the larval characters, are unsatisfactory and dangerous, and those on palpal structure, whilst being important, do not lend themselves to the method of simple grouping as do scale-structure ones.

There are numerous excellent illustrations, many of which are original. The absence of reference figures to these, however, in the text, is regrettable.

Mr. Theobald has our heartiest congratulations upon the completion of a most laborious piece of work.

W. E. C.

Wheeler, W. M.—Ants, their Structure, Development and Behaviour. Pp. xxv + 663, 1 plt. and 286 figs. New York: The Columbia University Press; London: Macmillan and Co., Ltd., 1910. Price, 21s. net.

This is a truly fascinating work, and at a time when the teaching of zoology consists almost wholly of an elementary knowledge of the structure of a few animal types (excellent as a means to an end), it will be welcomed by all who take an interest in the study of the life-history and habits of animals.

As the author points out, he has endeavoured to appeal to several classes of readers, viz., the general reader, the zoologist, the entomologist, and the comparative psychologist.

The work covers a wide field, and it is only possible here to very briefly outline the ground covered. He commences by reviewing ants as dominant insects, and instances a number of factors in proof; the probable cause of this dominance, their economic importance, and the maze of fascinating problems they present to the biologist are also dealt with.

Chapters 2-4 treat of the external and internal structure, chapter 5 with their development, chapters 6 and 7 with their polymorphism, whilst the remaining chapters deal with the history of myrmecology, the classification and distribution of ants, their habits, ant-nests, the relation of ants to vascular plants, the symbiotic relation between the fungus-growing ants and their fungi, the relations of ants to various insects, ant guests, ecto- and entoparasites, the compound nests, and parasitism, etc.

The three concluding chapters deal with the psychological and

metaphysical aspects, and there are also a series of appendices, including an extensive bibliography.

It is impossible in a review of a work of this extent to do more than point out the important topics dealt with, and to express our highest praise for such an able and valuable treatise, which should find a place in the library of every biologist and entomologist, and of every natural history society in the country.

W. E. C.

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Crawford, J. C.—New Hymenoptera from the Philippine Islands. Proc. U.S. Nat. Mus., 1910, vol. xxxviii, pp. 119-133.

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